NATIONAL COOPERATIVE SOIL SURVEY

West Regional Conference Proceedings

San Diego, California
February 13-l 7, 1978

Proceedings of .

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE

OF THE

NATIONAL COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA

FEBRUARY 13-17 1978

USDA-SCS-PORTLAND,OR.1978

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
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WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
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Conference Agenda

Sunday, February 12

5:00-7:00 Registration - Lobby

Monday, February 13

Chairman - Robert Meurisse

7:30 - 8:00 Registration - Del Mar Room

General Session - Del Mar Room

8:00 Announcement and Introductions

Organization Soil Surveys to Meet Today's Needs
Francis Lum, State Conservationist, California

Roll of the Universities in the Soil Survey Program

National Forest Programs and Use of Soils Data
J. Chattin, Deputy Regional Forester - Reg. 5

lo:oo Break

10:15 Role of Technical Service Center, SCS, in the Soil Survey Program
D. R. Robertson, Assistant Director. West Technical Service Center

The National Soil Survey Program
Klaus Flach, Assistant Administrator for Soil Survey

12:00-1:00 Lunch

Chairman - Sam Rieger

1:00-3:00 Panel - Research Activities in the Western States
R. Heil, Moderator

3:00-3:15

Wednesday, February 15

8:00-5:00	Field Trip R. Kover, J. Anderson, and G. Hartman - Tour Leaders Participants will leave the motel at B:00 a.m. by bus for a "transect" of San Diego County. At four stops we will observe various San Diego County soils. Lunch will be at the Chateau Basque Restaurant, Bankhead Springs. On our return we will observe some Forest Service fuel management practices and have an overview of the Imperial Valley. The transect will cover the thermic coastal beaches and foothills, the mesic mountains and the hyperthermic desert.

Thursday, February 16

Chairman - Robert Meurisse

8:00-10:00	Panel on Remote Sensing F. Peterson - Moderator
lo:oo	Break
10:15	Agency Reports Experiment Stations Forest Service Bureau of Reclamation Bureau of Land Management Bureau of Indian Affairs Geological Survey Agriculture Research Service Soil Conservation Service
12:00-1:00	Lunch

Chairman - Sam Rieger

1:00-5:00	Committee Reports

Friday, February 17

Chairman - Robert Meurisse

8:00-10:00	Panel - Design of Soil Surveys to Meet Objectives E. Naphan - Moderator
10:00-11:00	Business Meeting
11:DO	Adjourn

COMMITTEE MEMBERSHIP ASSIGNMENT
WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE
NATIONAL COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA
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Committee 1 - Soil Survey Operations

R. Fenwick, Chairman	R. Mitchel	R. Flenner
G. Simonson	H. Waugh	R. Montgomery
G. Kennedy	R. Mayko	G. Logan
E. Brown		

Committee 2 - Soil Survey Publications

D. Pease, Chairman	D. Stelling	R. Richardson
R. Kover	F. Peterson	E. Thomas
R. Parsons	R. Dansdill	P. Singleton
R. Noones		

Committee 3 - Improving Soil Survey Techniques

J. Anderson, Chairman	S. Brownfield	D. Richmond
G. Otte	H. Havens	A. Ness
J. Rasmussen	L. Giese	P. Derr
R. Huff	F. Spencer	D. Hendricks
O. Carleton		

Committee 4 - Soil Survey Interpretations

L. Langan, Chairman	J. Carley	J. Nishimura
D. Bell	J. Allen	G. Richard
H. Ikawa	R. Gilkerson	T. Collins
R. Heil	D. Gallup	E. Gross
O. Bailey		

Committee 5 - Soils and Soils Material Disturbed by Mining Operations

G. Nielson, Chairman	L. Daugherty	D. Jones
J. Rogers	D. Nettletan	T. Priest
D. Robertson	W. Peters	J. Jay
J. Chugg	T. Hutchings	E. Richlen

Committee 6 - Techniques for Measuring Source and Yield of Sediment

G. Huntington, Chairman	R. Tew	O. Harju
A. Leven	M. Fosberg	A. Erickson
E. Naphan	A. Ford	R. Nelson
A. Southard		

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
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Minutes of Annual Business Meeting, February 17, 1978, Del Mar Room, Bahia Hotel, San Diego, California.

The meeting was opened by conference chairman - Robert Meurisse.

The motion was made and passed giving approval to hold the 1980 meeting at the Bahia Hotel, San Diego, California, the week of February 10-15, 1980. Following the rotational system started at Phoenix during the 1976 meeting, Arizona was selected as the host state. In a separate action, Fred Peterson was selected as co-chairman of the 1980 conference to serve with Doug Pease.

Jack Chugg proposed and the conference approved a motion that Bureau of Land Management state soil scientists be added as permanent voting members of the conference.

The motion was made and passed to extend permanent voting membership to BIA area soil scientists in those areas with active soil survey programs.

Fred Peterson proposed a resolution that the conference format be restricted to a maximum of six committees with a ceiling of three charges for each committee. The resolution passed unanimously.

Meeting adjourned.

THE ROLE OF THE TECHNICAL SERVICE CENTER, SCS IN THE SOIL SURVEY PROGRAM

I have a great deal of respect and appreciation for soil scientists. Early in my career and throughout it 1 have been privileged to receive training and work with soil scientists. lhe backgrounding received has helped me develop a more solid base for my work. It has been a gratifying experience, too, to work in an interdisciplinary way with soil scientists. Some of the most productive and meaningful resource management tools I know of have been developed working with soil scientists.

Iam here as the Assistant Director for Technical Services of the Soil Conservation Service's West Technical Service Center. This is a new position as a result of our recent reorganization. At the beginning of this fiscal year, TSC's were reorganized to make them more effective and improve servicing states on an interdisciplinary approach.

The present organization provides for two assistant directors where previously there was one. One assistant oversees planning and operations activities. Staffs responsible for planning technology, cartography, information, employee development, automatic data processing, plus employees on assignment to EPA for non-point pollution control assistance are supervised by this assistant. The other assistant oversees technical services which include the soils, conservation technology, engineering, and snow survey and water supply forecasting staffs. This is my area of responsibility.

The TSC role and function can be grouped into seven categories. They are: (1) technical oversight, (2) direct technical assistance, (3) program counsel and guidance, (4) development of state staff competence and evaluation of their performance, (5) training and employee development, (6) interpretation and evaluation of national policies, and (7) keeping SCS technology current.

Technical Oversight - The TSC performs a major function in insuring that technical standards are adequate, adhered to, and utilized in all program activities. This function is performed in field reviews, through direct assistance, review and approval of complex efforts, and post reviews.

Direct Technical Assistance - Small states with limited staffs receive assistance where they lack expertise; larger states are assisted on complex problems; and in all cases, attention is being given to each to determine if each function is providing adequate services and meeting our quality standards.

Program Guidance and Counsel The TSC staff has a broader experience and are in regular contact with their Washington Office counterparts. This enables them to provide program opportunities and limitations for use in the state and how the available resources -- people, money, equipment, and authorities -- might be used effectively.

Development of State Staff Competence The TSC is responsible for assisting each state develop the level of staff capability and competence for meeting its workload. Then the process is monitored to assure these responsibilities are being met.

Training and Employee Development Most SCS training is given on-the-job in an actual working environment. TSC specialists assist in providing much of the technical training. There is also an Employee Development Staff at each TSC. When the training facilities and/or expertise are not available in the state, these needs are referred to the TSC Employee Development Staff for assistance.

Comments by Donald R. Robertson, Assistant Director for Technical Services, West Technical Service Center, SCS, Portland, Oregon, 2/13/78, at west Technical Soil Survey Conference, San Diego, California.

Interpretation and Evaluation of National Policy - National SCS policy tends to provide broad guidance and direction. The State Conservationist has considerable latitude for setting priorities, organizing, and directing our work in the state. TSC experience, expertise, and relationship as an extension of the Washington Office is used to help interpret, understand, and implement conservation assistance in the states. Good operating policies and procedures arc a dynamic process also. Poorly conceived or irrelevant policy is an impediment to effective delivery of programs and services. The TSC monitors , evaluates, and recommends changes in state or national policy as needs are identified.

Maintaining Current Technology - TSC specialists are responsible for keeping abreast with

How do we see these, and ongoing soils work, impacting on the West TSC?

All the useful management tools and techniques available to us need to be employed as our workload continues to increase. We will continue to sharpen our workload analysis, set priorities, and develop annual plans of operations directed toward the best management possible.

Effective scheduling must be employed to implement the Annual Plans of Operations.

At the West TSC we will continue to evaluate the direction, magnitude, and priorities for TSC services. We expect to continue to emphasize our coordination between states and among disciplines and build on the good cooperative relations among agencies. It is our desire to provide the best quality, most timely service to further the progress of NCSS with all cooperators.

Forest Service Activities in the National Cooperative Soil Survey

Kermit N. Larson
U.S. Forest Service
Washington, DC

The Forest Service welcomes the opportunity to participate in this conference and report to you on our soil survey activities.

A fundamental goal of the FS is to manage the National Forests for multiple purposes at a high level of sustained periodic output of goods and services "without impairment of the productivity of the land." This goal is further amplified in the Forest and Rangeland Renewable Resources Planning Act. This Act directs the Secretary of Agriculture to develop an assessment and long-range program for the Nation's renewable resources that will assure an adequate supply of forest and range resource while maintaining the integrity and quality of the environment. As part of the assessment, the Secretary is directed to provide, on a continuing basis, a comprehensive and appropriately detailed inventory of all National Forest System lands and renewable resources. This includes an assessment of the present and potential productivity of the land. Furthermore, the Act specified that for National Forest System land management plans, a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic and other sciences be used.

Other goals of the FS to which the soils program must respond are:

> "Promote and achieve a pattern of natural resource uses that will best meet the needs of people now and in the future."

- Promote high quality multiple use management on National Forests and other ownerships, where applicable.

- Share expertise in specialties where the Forest Service constitutes the prime source of experience and skills: nature, properties and management of forest soils.

- Cooperate with other federal, regional, state, multicounty, and county agencies in resource management, and in planning and economic development programs.

"Protect and improve the quality of air, water, soil, and natural beauty."

- Promote practices to protect and enhance environmental quality in management of all forest ownerships.

- Encourage prevention and abatement of air, water and soil pollution from operations of forestry-related enterprises.

"Develop and make available a firm scientific base for the advancement of forestry."

- Make research results rapidly and equally available to all through information, education, demonstration, and technical assistance.

- Foster relationships between research scientists and forest managers that facilitate joint implementation of research results.

The Forest Service soil management program is a primary contribution to this data base. It is designed to provide knowledge about the soil resource including an assessment of soil capabilities and suitahilities for use in land and resource planning and decision-making, for resource development, and the protection of forest, range and related lands.

While the soil resource inventory is a major part of the soils program, a great deal of effort is expended on non-survey activities. At least 50 percent of our staff capability in the soil area is for land management Planning, other support services activities such as on-the-ground advice and counsel regarding timber sales, reforestation projects, range improvement projects, and constructive activities.

A principal goal for soil inventory within the Forest Service for the past 10 years has been to keep pace with soil requirements for resource and land management planning. We have been able to keep pace with this need by primarily conducting order 3 and 4 surveys. Presently, we have completed about 75 percent of the total acreage of National Forest System lands. Most of these surveys are order 3 or 4. Our goal is to complete soil resource inventories suitable for land management planning on all National Forest System lands by 1985. At the present rate of accomplishment, we should achieve this goal.

The National Cooperative Soil Survey.

Questions have been raised concerning the relationship of the Forest Service soil resource inventories and the National Cooperative Soil Survey. During the joint Soil Conservation Service - Forest Service coordination meeting in January 1976, it was mutually agreed to review this relationship. As a result, a joint task force was designated with the charge to review the goals of each agency with respect to the procurement and use of soil information. A document was to be prepared that could be distributed to field offices in order to enhance mutual understanding and cooperation in this area of effort. This document has been completed, and has been approved by the Chief of the Forest Service, and the Administrator for the Soil Conservation Service.

Most of you are familiar with this report, but it basically reafirmed the viability of the Memorandum of Understanding between the Forest Service and Soil Conservation Service regarding soil surveys. It also indicated that recent changes in procedures to accelerate correlation and publication within the framework of the NCSS offers the opportunity to attain a greater degree of overall coordination. Both agencies have taken action regarding the recommendations of this task force. One of the actions the Forest Service has taken in response to Recommendation No. 1, is to develop quality control standards for soil resource inventories. The following standards are now applicable to all soil inventories in the Forest Service.

Soil resource inventories, including In-Service soil resource inventories, will meet as a minimum, the following standards:

1. An approved work plan will be required for each soil resource inventory.

2. A field soil notebook will be assembled and kept current for each soil resource inventory.

3. All soils will be classified according to "Soil Taxonomy," United States Department of Agriculture, December 1975.

4. Intensities (orders) of soil resource inventories will conform to those orders described in "Kinds of Soil Surveys" Committee Report No. 7 of the National Soil Survey Technical Working Planning Conference.

5. A minimum of two field reviews, one of which will be a final review, will be performed for each ongoing soil resource inventory.

6. An In-Service soil resource inventory report will be prepared following the completion of each soil resource inventory.

Soil resource inventories that are made within the framework of an integrated inventory, such as land systems inventory, ecoclass and other ecosystem inventories, will also conform to the above standards.

What's Ahead.

Presently, about 30 percent of the soil inventories in the Forest Service have been accomplished within the NCSS. The percentage has increased considerably in the past 2 years. I believe it will continue to increase in the years ahead.

Recent legislation such as RPP and the National Forest Management Act, require the Forest Service secure detailed soils information on much of our land. This means we will have to convert many of order 3 and 4 surveys to order 2 and 3. This effort will allow us the opportunity to incorporate our In-Service soil inventories into the NCSS.

The objectives of the National Cooperative Soil Survey are consistent with Forest Service objectives regarding soil survey; that is securing reliable, accurate and creditable soils information for use and management.

Reports of Agencies Participating in the
National Cooperative Soil Survey

U.S. Department of the Interior
Bureau of Reclamation Activities

Soil science and related activities within the Bureau of Reclamation primarily relate to water and land resource development. Following are examples of typical Reclamation activities:

a. Economic land classification for irrigation
b. Wetland surveys
c. Drainage and reclamation of salt-affected lands on existing irrigation projects
d. Soil characterization for irrigation scheduling
e. Revegetation of lands disturbed by construction activities
f. Reclamation of lands disturbed by surface mining
g. Soil and moisture conservation programs, including vegetation conversion (e.g., brush to grass)
h. Land and water appraisals for environmental studies
i. Prediction of return-flow water quality
j. Water quality control, particularly salinity of major river systems
k. Remote sensing for land resource inventories and land use planning
l. Engineering properties of soils related to construction activities as well as sedimentation and erosion studies
m. Assistance to foreign countries in selection of lands for irrigation or reclamation
n. Participation in interagency affairs, committees, workshops, and professional societies

Reclamation land

Following is a somewhat more detailed outline of some particular items of interest within the general outline of activities given above.

<u>Reclamation Potential of Lands Disturbed by Surface Mining</u> - Our agency is conducting (under contract with USDI-BLM) investigation of specific sites which are within general areas considered to be likely candidates for surface mining (coal) activities. Our objective is to assess the reclamation or rehabilitation potential of these sites and to provide BLM with sufficient data to assist them in formulation of lease stipulations to be used on Federal lands. This involves obtaining basic data, making evaluations; developing standards, guidelines, techniques, and alternate plans for rehabilitation; and restoring vegetative growth. Overburden[1/] is characterized for its suitability as a plant growth medium, and sources of suitable material are located and quantified. Geologic cross sections are logged, and bedrock physical and chemical characteristics are identified,

This work is approached on an interagency and interdisciplinary basis. One of Reclamation's strong points in this regard is that it is itself an organization containing individuals of many disciplines, and expertise in engineering, geology, soils, agronomy, archeology, etc., is available internally. Reclamation's role includes correlation and coordination of data received from other agencies into a final report. Part of this coordination, as it applies to the land resources of the area, includes contact with Soil Conservation Service, and use of soil survey data wherever it is available. It has also been our practice to work with Soil Conservation Service soil scientists in the field, wherever possible, to achieve a reasonably accurate soil survey in addition to a Reclamation type land classification of the study site area. While it must be recognized that soil surveys and land classification serve different purposes, Reclamation recognizes the value of both in providing resource planners with the data they need in managing lands before, during, and after surface-mining operations.

In characterizing overburden, sufficient exploration is accomplished to describe and collect representative samples of soil and substrata to a depth below overburden and coal (maximum depth of 200-250 feet). Sampling of overburden at selected master sites is comprehensive, as is analysis of samples from these sites. At other points of examination, representative samples are selected for laboratory characterization on a screenable basis to confirm judgment in field appraisals.

1/ Overburden is the material consolidated or unconsolidated overlying the coal.

The first priority in the agronomic laboratory characterization of soil is directed toward direct and indirect measurements to evaluate soil structure and stability, effective soil cation-exchange capacity, and soil reaction. After this is completed, consideration is given to testing that confirms the field characterization, explains the causes of phenomena previously observed or predicted, reveals the presence of toxic substances (salinity level, boron content, alkali, acidity, reduction products, heavy metals, etc.); and indicates measures required to cope with the soil and/or land deficiencies under anticipated field conditions.

Representative samples from within the site are further subjected to greenhouse studies conducted at Colorado State University. These studies are designed to assist in determining the relative capacity of a given material to support vegetation along with an indication of how these materials change (physically and chemically) over time in response to revegetation practices. Additionally, these studies have the potential of assisting in the detection and identification of toxic conditions or unacceptable levels of trace elements. It should be borne in mind that these studies do not replicate actual field conditions and do not indicate projected plant material yields at the site, but act primarily as a screening test to indicate potential adverse conditions.

Concurrently, with the above described investigation, the overburden is also characterized for geological, hydrological, and engineering properties. USGS is responsible for ground-water data collection and for assessment of the effects of mining on the hydrology and water quality of the area.

As can be seen from the above outlined procedures, these studies are relatively intense and provide detailed data for the specific site under study.

This work was initiated in 1974, and is continuing at this time at a rate of about five site studies per year. Experience gained to date from these studies has enabled us to tailor our investigations to conditions present in the area, and avoid collection or generation of superfluous data.

<u>Irrigation Management Services Program</u> - The Irrigation Management Services Program was initiated by the Bureau of Reclamation to assist water users in more efficient use of their water supplies. It is presently directed toward achieving better water management

on the farm, but its ultimate aim is to extend this efficiency to irrigation distribution and storage systems. The beneficiaries of this program are expected to financially support it (at least in its operational stages); and while the idea is not unique to Reclamation (computerized irrigation scheduling services are available through many commercial consultants), the combined approach of maximizing economic returns and efficiencies on an equal basis of priorities in order to conserve water, reduce drainage requirements, and optimize irrigation distribution system capabilities is somewhat less common. The establishment of the Irrigation Management Services program within irrigation and water districts is normally a cooperative effort with the Soil Conservation Service and the Extension Service.

Predicting Quality of Irrigation Return Flows - Reclamation has developed a computer simulation model which aids in the prediction of both quantity and quality of return flows from irrigation. This model is currently operational and has been used, in whole or in part, in various areas of the western United States and in some foreign countries. The model currently simulates concentrations of major cations and anions, and nitrogenous species, and will be expanded to include phosphates, pesticides, and trace elements.

Although currently operational, this model is being continuously tested and refined to increase its accuracy and usefulness. Determination of the best sampling procedures to obtain accurate and representative data remains a critically important part of this program. Additionally, a major area of concern is the characteristics of aquifer material below the soil profile where data collection, at least in the past, has not been so intensive.

Colorado River Water Quality Improvement Program - The purpose of this investigation is to develop plans for controlling salinity in the lower reaches of the Colorado River to meet salinity standards set for the lower main stem. The mineral burden of the Colorado River is the foremost water quality problem in the basin, and carries both interstate and international implications. Continued development of the water resources is expected to generate additional salinity increases with concommitant economic losses to agriculture and M&I users if the salinity is not controlled. Natural sources contribute most of the salinity to the river. Return flows from irrigation and municipal and industrial uses also add significant quantities of salt. Moreover, concentrating effects are produced by water exports out of the basin, use of water by vegetation, and evaporation from free water surfaces. This investigation program will consider individual problem areas, develop control plans, and make specific recommendations for remedial actions. The extreme complexity of the situation outlined above, coupled with legal and political implications, renders this program one of the most difficult of practical solutions that Reclamation has been involved with.

Land Use Planning - Although not directly involved in land use planning on a community-wide basis, Reclamation is vitally interested in assuring that its project development activities fit in with the orderly development of the areas in which they are located. In addition, we have the direct responsibility for planning suitable and desirable uses of the lands under our agency's immediate control. For these reasons, evaluation of land resources in terms of ultimate uses other than irrigated agriculture is a part of Reclamation's planning activities.

We are aware that the Soil Conservation Service is, and has been, highly involved in developing land use suitability ratings for soils mapped in soil survey activities. These rating systems, as well as the soil surveys themselves, have proven to be very useful to Reclamation in its land use planning activities. We expect to cooperate with SCS in the future in the use and development of these systems, and in other land use planning activities.

We are currently in the developmental stages of a computerized system of storage of land use suitability data and its manipulation in order to achieve projections of future conditions in areas affected by Reclamation project development. This computer program (CMSII) was developed by the Federation of Rocky Mountain States in Denver, and is presently used by many governmental entities in that area. Its adaptation to Reclamation activities is expected to greatly enhance our ability to carry out and assist others in land use planning activities.

Remote Sensing Activities - Reclamation continues to support research in remote sensing for many applications including land classification and land use planning. Soil science and land classification remote sensing activities have been limited so far to the more gross features including soil moisture and salinity, but more specific detailed applications are under consideration, and would be used when practicality is established. Land use planning lends itself more readily to the application of remotely sensed data. Consequently, remote sensing of vegetative type, cultural features, wildlife habitat, etc., is presently operational within Reclamation and, coupled with the CMS11 computer program mentioned previously, is presently being implemented in our planning procedures.

Assistance to the Developing Countries - Reclamation has provided technical assistance in the field of multiple-purpose water 'resource development to over 100 developing nations. This assistance has been highly varied, encompassing many disciplines, including engineering, economics, geology, hydrology, soil science, agronomy, and environmentalism. It can be reduced to three broad categories: (1) the gratifying task of training foreign nationals in our facilities at home, (2) providing direct consultation on various aspects of water resource developments abroad, and (3) the challenge of water resource planning abroad, accomplished with counterparts from the host nations. The latter primarily involves early reconnaissance-type investigations and preparation of reports to the governments requesting these services. Detailed feasibility studies, design, and construction are usually carried out under contracts between the governments and private firms. The work is helping through mutual effort to unleash the grip of economic stagnation and the corollaries of poverty, hunger, and substandard living.

Reclamation is currently, through the United States Agency for International Development, providing assistance in irrigation suitability land classification to the Niger River, Senegal River, and Gambia River areas in Western Africa.

Land Classification - Summaries on land classification activities by states are presented in tabular form on table 1.

Table 1

IRRIGATION SUITABILITY LAND CLASSIFICATION

Fiscal Years 1977 and 1978

California

Allen Camp
Butte Valley
Lake county
Mid-Valley, Raisin City
Solano County
Sacramento River Seepage Project
Napa County
Ventura County
Yolo County

Colorado

Animas-La Plata Project
San Miguel Project

Idaho

Middle Snake River area
Salmon Falls Project
Upper Snake River area
Oakley Fan Division
Southwest Idaho area
Ririe area

Kansas

Kanopolis Unit

Montana

Upper Missouri River Basin Project Flathead area

New Mexico

Animas-La Plata Project
Jicarilla Apache Indian Reservation

North Dakota

Garrison Unit
Apple Creek area

Oklahoma

Oklahoma State Water Plan Southwest 20 counties
Waurika Project - Northwest 44 counties

Oregon

Grants Pass Irrigation District
Warm Springs Indian Reservation
Merlin Division
Medford Division
Umatilla Basin Project
Tualatin Project
Baker Valley

Table 1--Continued

South Dakota

Oahe Unit	Grass Rope Unit

Utah

Central Utah Project, Bonneville Unit	Uintah Unit
Leland Bench Unit	Ute Indian Reservation
Upalco Unit	

Washington

Yakima Indian Reservation	Bumping Lake Enlargement
Spokane Indian Reservation	Omak East
Columbia Basin Project	Benton Irrigation District
Yakima River Basin	Kalispel Indian Reservation
Colville Indian Reservation	Brewster Flat
Touchet Division	Kittitas area
Kennewick Division Extension	Oroville-Tonasket Project

Wyoming

Sublette area	Shoshone Project, Polecat Bench
Riverton Project	

Investigators: D. M. Hendricks, D. F. Post

Investigator: D. M. Hendricks

Objectives: (I) Determine the bio-physical and socio-economic factors in influencing non-urban land use. (II) Organize and deliver existing bio-physical and socio-economic land related data needed for land use policy making and planning. (III) Develop critically needed data and interpretations for land use policy making and planning; develop and evaluate alternatives to overcome soil limitations and environmental degradation.

Approach: Objective II - a bulletin, "The Soils of Arizona, A Comprehensive Overview" to accompany the General Soil Map of Arizona describing in detail the soil mapping units and relating the soils to the latest concepts concerning the geology. vegetation, and climatic (including paleoclimate) of the State. Objective III - a major research effort will be directed to the adaptation and use of remote sensing technology to accelerate the mapping of soils, vegetation, and land use in Arizona.

SOIL SURVEY RESEARCH ACTIVITIES
UNIVERSITY OF CALIFORNIA

Titles of research activities within the California Agricultural Experiment Station, considered to be of importance to soil survey, are listed below under Research Program Areas (RPA's). The Work Unit/Project No. will provide access to annual CRIS reports from the projects for additional details.

The activities are being carried on by different departments on 3 of the 9 UC campuses. The key to the Work Unit Symbols is as follows:

CA = California (AES);
B* = Berkeley;
D* = Davis;
F* = Forestry and Conservation;
R* = Riverside;
ARS = Agronomy and Range Science;
FRU = Forest Research Unit;
SPN = Sails and Plant Nutrition;
SSE = Soil Science and Agricultural Engineering;
VCR = Vegetable Crops; and
WSE = Water Science and Engineering.

The number in parenthesis preceding the project title denotes the percentage of effort of the project devoted to the particular RPA.

RPA 101	Appraisal of Soil Resources
CA-B*-SPN-2492	(100) Genesis and mrpholagy of the Pygmy Forest-Blacklock soil ecosystem.
CA-B*-SPN-2589H	(100) Multivariate analysis of soil data for soil classification, correlation and interpretation.
CA-D*-ARS-3312	(15) Grassland aspects of the state cooperative soil-vegetation survey.
CA-D*-SPS-2845RR	(20) Soil interpretation and socio-economic criteria for land use planning (subproject: Environmental factors and soil properties determining erodibility of California soils).
CA-D*-SPN-3197H	(100) Characterization, classification and mapping of California soils and related pedological studies.
CA-R'-SSE-2892	(70) Characterization of soils and interpretations of their genesis and use limitations.

RPA 102	Soil, Plant, Water, Nutrient Relationships
CA-B*-SPN-2893H	(100) Effects of prolonged leaching on the physical and chemical properties of soils.
CA-D*-SPN-3194H	(50) Soil factors in relation to forage quality.
CA-D*-SPN-3198H	(30) Nitrogen in the environment.
CA-D*-SPN-3201H	(100) Characterization and amelioration of problem soils.
CA-D*-VCR-3179H	(50) Land as an acceptor of biodegradable solid wastes.

CA-D*-WSE-3461H

CA-F*-FRU-1762

CA-F*-FRU-2937MS

CA-R'-SSE-1963

RPA 103

CA-D*-SPN-3193H

CA-D*-WSE-3086RR

CA-D*-WSE-3538H

CA-R*-SSE-3776

CA-R*-SSE-3784H

RPA 104 Alternative Uses of Land

CA-B*-SPN-2848RR (100) Soil interpretations and socio-economic criteria for land use planning. (Subproject

RESEARCH ACTIVITIES SUMMARY

A summary of research activities at Colo. State Univ. of potential interest to soil survey programs.
Compiled by: R. D. Heil - Dept. of Agronomy, Colo. State Univ., Ft. Collins, Colo. 80521 for distribution at the Western Regional Soil Survey Work Planning Conference, Feb. 13, 1978, San Diego, Calif.

Research Project Title	Objectives	Funding and/or Coop Agencies	Investigator/s
1. Land Capability Data Base	To provide soil characterization and interpretive data for all Colo. counties on a soil-association basis.	Colo. Exp. Sta. and Soil Cons. Service	D.C. Moreland-SCS R.D. Heil-Exp. Sta. J. Cipra-Exp. Sta.
2. Applicability of Remote Sensing for Identifying Erosion Condition	Test the applicability of computer generated Land-Sat imagery for identifying erosion condition.	USFS	J. Cipra R. Heil
3. Characterization of Geologic Strata Overlying Coal Seams	Geochemical characterization and greenhouse studies to evaluate the suitability of geologic materials overlying coal seams as plant growth media	USBLM	R.
"Delphi" Applied to Soil Survey	To determine the usability of the "Delphi" survey technique in gathering research and experience data for making and improving soil interpretations		R. Williams R. D. Heil
5. Socio-economic and Physical Impacts of Transferring Water from Irrigation to Urban Use	A case study		R. Anderson R. D. Heil Norm Wengert
6. Important Farmlands	A joint effort between SCS and Exp. Sta. to develop important farmland maps of Colo. Counties using national criteria and developing criteria for identifying important farmlands of state and local interest		
Soil-landscape-erosion Relationships	A study to characterize the soil - landscape - erosion conditions on a selected semi-arid grassland site.	Colo. Exp. Sta	
Soil Information Needs in Developing a Mined Land Reclamation Plan	A study to develop guidelines for sampling, characterization and interpretation of soil data needed in the development of a mined land reclamation plan	USFS	
Characterization of Reclaimed Mined land Areas	A study to characterize and classify soils on 2 reclaimed mined land areas.	USBLM SCS Cooperating	
Land Application of Waste Materials	A number of studies are ongoing to research the effects of applying various wastes to soils.	-	
11. Mined land Reclamation	Field, laboratory and greenhouse studies on problems associated with revegetation and stabilization of mined land areas.	-	W. Berg

SOIL SURVEY RESEARCH ACTIVITIES--MONTANA STATE UNIVERSITY

Western Regional Soil Survey Work Planning Conference,
San Diego, February 13-17, 1978

Generalized State Soil Map of Montana: Publication of map (1:1,000,000 scale) and development of an accompanying bulletin.

Montana Automated Data Processing System: Apply system data bank to current Experiment Station research projects such as clay mineralogy, soil genesis and classification, fertilizer response, etc. Continue application of system for on-going county soil surveys in Montana (several thousand pedon descriptions are prepared and stored annually).

Computer-graphic System for Storage and Display of Natural Resource Data: Eighteen environmental factors (e.g., soil, natural vegetation, geology, frost-free season) were stored for easy retrieval and display as 1:1,000,000 scale maps. The system will be used to compare the environments of Montana's Experiment Station research centers to those of the whole state to determine regions where on-station research is most applicable.

Western Montana Soil Temperature Study: Develop models to estimate soil temperature regimes for forest and range sites in the mountains and foothills of western Montana.

Erosion and Sedimentation from Flexible Cropping Systems in Montana: Evaluate the sedimentation and erosion produced under the new flexible cropping systems as compared to the traditional crop-fallow system on three benchmark soils in Montana.

Statewide Water Monitoring System: Development of a system to evaluate stored soil water to provide timely Information for farmers to use in making planting vs. fallowing decisions.

Minesoil Resources in the Powder River Basin--Characterization, Evaluation, and Potentials: To characterize morphological, physical, and chemical properties of minesoils and to develop criteria for evaluating the potential of minesoils for selected land uses.

Pedologic Characteristics of 2 to 50-year-old Stripmine Spoils in Southeastern Montana: Evaluate the morphological, physical, and chemical properties of minesoils of varying age and nearby undisturbed soils to compare their development processes and their potential uses.

SOIL SURVEY RELATED RESEARCH PROJECTS
NEVADA AGRICULTURAL EXPERIMENT STATION

1. Hatch 520 (W-125): Soil interpretations and socio-economic criteria for land use planning. (Regional project). F. F. Peterson; cooperative with E. A. Naphan, Soil Conservation Service.

Nevada Objectives: Development of general state soil map at 1:750,000. Development of state soil temperature regime and soil moisture regime maps to support soil map. Soil temperature regime work well advanced; preliminary soil delineations progressing; moisture regime studies in planning stages.

2. BLM 680: Properties, occurrence and management of soils with vesicular surface horizons. R. Eckert and F. Peterson.

In Nevada, soils of the alluvial fan piedmonts divide, roughly, into those with silty, vesicular crusted, polygonally cracked surfaces north of U. S. Hwy. 50, in the "Humboldt loess belt", and those to the south with a gravel pavement or sandy or gravelly mulch over a polygonally cracked, vesicular curst. Within the loess belt four distinctive surface marphological types are correlated with coppice dune, coppice bench, intercoppice microplain and playette microtopographic positions and presumably related to surficial moisture tension regimes. Cracks between polygons provide safe-sites for seedlings. (c. f., Hugie and Passey's earlier work.)

Dust-fall (about 6 cm) and infiltration have been demonstrated to be a reasonable genetic mechanism for development of vesicular crust in coarse textured alluvium in southern half of Nevada.

Various standard range seeding trials and hand-placed seedings in polygon cracks, on polygons, and with and without trampling-incorporation are in progress.

SOIL SURVEY RELATED RESEARCH PROJECTS
NEW MEXICO STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

The following research projects are designed to either "se soil survey information or to provide basic information for soil surveys.

A computerized land resource inventory system is being developed in conjunction with the Agricultural Economics Department for the Mesilla valley in southern New Mexico. Information regarding soils, water, topography, physical structures and existing land uses are initially being compiled for a six township area surrounding Las Cruces, N.M. Computer mapping capabilities allow soils information to be used alone or in combination with the other components of the data base for land "se interpretation and local planning activities.

The following research projects are designed to provide critically needed data for soil surveys and their interpretation:

Title: Predicting sail loss from forest watersheds.

Objectives: (1) To determine amounts of surface erosion from different cover conditions on a major soil type found an the Lincoln National Forest in New Mexico;
(2) To compare the measured soil erosion from these vegetation cover types to that predicted by existing soil loss equations.

Two study sites have been selected near the town of Sacramento, New Mexico (Lincoln National Forest). The sites are on similar slopes, elevations, aspects and soils. The major difference in the sites is vegetative cover. Site (A) was burned-over in the Spring Burn, 1974, and Site (B) is a native stand of Ponderosa pine with some Douglas-fir and southwestern white pine. The slopes range from 20-40 percent, elevation ranges from 7500-7700 feet. The aspect is northfacing and the soils are Typic Argiborolls.

Transects have been delineated at each site. Transects are approximately 90 meters long (perpendicular to the contour) with erosion measurig stations positioned at 5 meter intervals. A station consists of 3 re-bar sections (placed 1 meter apart along the contour) located so a measuring device can be securely fastened to the re-bar in the same position in repeated measurements. Five rods (arrows) are lowered from the device to the ground surface to determine the surface relief. The three r-e-bar sections allow 4 positions to be read at a station or a total of 20 erosion readings (4 positions X 5 readings/position). There are between 15-18 stations per transect and two transects per site.

Title: Soil moisture determinations for use in soil classification.

In the process of making soil surveys in the Western United States, problems have arisen in the classification of soils due to the lack of soil climatic records. Because of the lack of available information, disagreement has resulted in the transition zones between soils with aridic and ustic moisture regimes. Because of the lack of soil moisture data, predictions of soil climate have been made from point source climate stations using long term rainfall records and potential evapotranspiration. The climate changes and the soil-climate transition zones are cuased by localized orographic changes. A computer model has been developed by predict moisture accretion and depletion in the western United States. However, long term point source climate data must be used.

The general objective of this project is to measure soil moisture in several transition zones between aridic and ustic soil moisture regimes in New Mexico by taking the following approaches:

(1) Measuring soil moisture at or near long term weather stations located in the critical moisture transition zones in order to test existing models.

(2) Measure soil moisture in transects across the soil moisture transition zones to locate the critical changes.

The initial research sites have been selected near Ruidoso, New Mexico. Nine data collection paints have been located between Carrizozo (aridic) and Ruidoso (ustic). The soils at these sites are being sampled for characterization and moisture sensors are move.

Title: Characterization of selected soils situated on national resource lands within Socorro, San Juan and McKinley Counties, New Mexico.

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OREGON STATE UNIVERSITY
LIST OF STATE-SUPPORTED RESEARCH PROJECTS

SOIL SCIENCE

PROJECT NUMBER	PROJECT TITLE	PROJECT LEADER & CO-INVESTIGATORS	REMARKS	TERM
042	Soil as a Waste Treatment System	V.V. Volk	REGIONAL W-124	0772-0977
056	Soil-Plant Nutritional Relationships	O.P. Moore	HATCH	0771-0678
070	Irrigation Scheduling of Agricultural Crops	C.H. Ullery		0771-0676
072	Description, Classification & Landscape Distribution of Oregon Soils	G.H. Simonson		0773-0778
073	Relationship Between Response From Fertilizers, Soil Analyses, & Chemical Compositions of Field Crops	T.L. Jackson		0772-0678
131	S-Urea Transformation. Movement & Effect on Plant Growth Under Different Soil Conditions	M.D. Dawson L.L. Boersma		0772-0678
173	Development, Improvement & Calibration of Soil Tests	E.H. Gardner		0772-0680
287	Nodulation Problems on Legumes in Oregon	C. Hagedorn		0475-0580
306	Sub-Surface Disposal of Household Waste	M.E. Harward		0775-0680
324	Sewage Sludge & Poultry Waste Application to Land	V.V. Volk T.L. Willrich T.L. Jackson C. Hagedorn L.W. Martin		0775-0680
337	Soil Erosion Control in the Pacific Northwest	M.E. Harward G.E. Kling G.H. Simonson	STEEP	0176-1280

LIST OF STATE-SUPPORTED RESEARCH PROJECTS

SOIL SCIENCE

PROJECT NUMBER	PROJECT TITLE	PROJECT LEADER & CO-INVESTIGATORS	REMARKS	TERM
419	Soil Water & Its Management in the Field	L.L. Boersma	REGIONAL W-68	0774-0979
42c	Application of Information on Water-Soil-Plant Relations to Use & Conservation of Water	L.L. Boersma	REGIONAL W-67	0774-0979
464	Effects of Fertilizer & Lime Treatments on the Yield & Chemical Composition of Vegetable crops	T.L. Jackson D.P. Moore		0772-0680
474	Forest Soil Fertility	C.T. Youngberg		0772-0682
476	Soil Interpretations & Socio-Economic Criteria for Land-Use Planning	G.H. Simonson J.B. Stevens-AgEcon	REGIONAL w-125	0772-0977
480	Soil Colloids in Relation to Pacific Northwest Soil & Water Management Problems	J.L. Young C.L. Douglas	USDA/ARS	0774-0679
562	Investigation of Factors which Affect Sulfur Uptake by Forages	E.H. Gardner		0771-0678
591	Symbiotic Nitrogen Fixation in *Ceanothus*	C.T. Youngberg		1163-0679
873	Dissipation & Degradation of Herbicides & Related Compounds in Soil & Water Systems	V.V. Yolk	REGIONAL	0774-0679
885	Potato Fertility - Relationships Between Soils & Plant Chemical Analysis & Yields	T.L. Jackson M.J. Johnson-Central OR G. Carter-Klamath L. Fitch-Malheur		0172-1277

LIST OF STATE-SUPPORTED RESEARCH PROJECTS

RANGELANO RESOURCES

PROJECT NUMBER	PROJECT TITLE	PROJECT LEADER & CO-INVESTIGATORS	REMARKS	TERM
113	Western Oregon Rangeland-Animal Relations	W.C. Krueger		0772-0678
155	Forage Production & Utilization on Western Oregon Rangelands	G.D. Savelle		0773-0678
276	Range Watershed Management	J.C. Buckhouse		0175-0679
342	Range Management & Improvement	T.E. Bedell		0976-0681
367	A" Ecological Evaluation of Fire, Chemical & Mechanical Treatments on Sagebrush Ranges	A.H. Winward		0377-0681
429	Ecology & Management of Foothill Rangelands	W.C. Krueger		0772-0678

SERVICE/ADMINISTRATIVE PROJECTS:

Number	Title
200	Planning & Direction of Research

LIST OF STATE-SUPPORTED RESEARCH PROJECTS

AGRI. ENGINEERING

PROJECT NUMBER	PROJECT TITLE	PROJECT LEADER & CO-INVESTIGATORS	REMARKS	TERM
116	Animal Waste Management Systems for the 1980's	J. Koelliker T.L. Willrich R.B. Wensink	REGIONAL NC-93	0775-0980
180	Improving Water Supply Forecasts & Their Use	T.A. George R. Jones		1076-0981
182	Harvesting & Processing Seed Crops	J.K. Park N.R. Brandenburg		0561-0677
183	Trickle Irrigation to Improve Crop Production & Water Management	M.N. Shearer R.H. Brooks	REGIONAL W-128	0773-0678
197	Systems Engineering Applied to Energy & Waste Management in Agriculture	R.B. Wensink	HATCH	1074-0677
314	Energy Requirements of Irrigation Systems	R.B. Wensink J.W. Wolfe	REGIONAL w-140	0775-0979
316	Systems Growth Modeling of Agricultural crops	L.H. Fuchigami (Hort) R.B. Wensink		0775-0677
360	Agricultural Structures Design Utilizing Alternate Energy Systems, Materials & Concepts	M.L. Hellickson		1076-1078
418	Drainage of Stratified Soils	R.H. Brooks		1158-0677
525	Mechanization of Harvesting & Handling of Horticultural Crops	D.E. Booster D.E. Kirk	Rev. 7/75	07754680

FORESTRY EXPERIMENT STATION PROJECTS

PROJECT TITLE	PROJECT LEADER	REMARKS
Sediment Transport in Small Mountain streams	R.L. Beschth	
Soil Compaction From Logging Vehicles	H.A. Froehlich	
Stream Protection During Timber Harvest Activities	H.A. Froehlich	
Forest Roads and Slope Stability		Cooperative with Civil Engineering
Brushfield Analysis of Clearcuts Using Multi-band Stereoscopic Aerial Photography	D.P. Paine	

SOIL SURVEY RESEARCH ACTIVITIES
DEPARTMENT OF SOIL SCIENCE AND BIOMETEOROLOGY
UTAH STATE UNIVERSITY

Members and students in the Department were very active as can be seen in the following pages. Teaching loads generally increased as did the number of students in the department. Research efforts and grants generally increased. Prospects for the future look promising. A new staff member, R. J. Wagenet joined us this year.

Three staff, R. L. Smith, Don Kidman, and Tom Fullerton were on assignment in South America. In addition, Dave James had major responsibilities for technical direction of the US-AID on-farm water management project again this year and visited many countries in South America on this assignment. Inge Dirmhirn was in Norway for four weeks to teach a course in "Biometeorology Radiation." Jerry Jurinak and Al Southard were bath in Brazil on short term teaching assignments. John Skujins was in USSR, Egypt and Mexico on research and teaching assignments. Gene Wooldridge attended an International Mountain Meteorology meeting in Switzerland. Wynne Thorne did his usual amount of world-wide travel to the extent that we haven't been able to catch him to get the details.

The basic role of the Department to serve the needs of the people of the state and the nation was improved on all fronts this year. Analysis done by the Soil, Plant and Water Analysis Laboratory under Reuel Lamborn increased and more people were served this year. Assistance in Soil Survey continued to be a major task of Al Southard and the not-so-retired LeMoyne Wilson. REX Nielson expanded his role as farm "shape up." Paul Daniels and Paul Christensen continued to tell our story to the public as well as carrying on research of their own.

Following is a brief summary of some of our current activities:

1. Soil, Plant and Water Analysis Laboratory. Services directly useful to Utah Farmers are:

    a. Soil analysis for fertilizer recommendations and diagnosis of salinity problems.

    b. Water analysis for irrigation or livestock use.

    c. Feed analysis for dry matter, ash, protein, phosphorus, and other nutrition elements.

5. Salinity Problems in the Upper Colorado River Basin. Studies are underway to find ways of minimizing the salt being carried in the surface waters from natural diffuse sources in the Price River Basin area. Jerry Jurinak.

6. Soil as a Waste Disposal System. Research is being conducted to determine the effect of different drilling fluid mixtures from oil drilling on plant growth and soil conditions. Also guidelines have been drawn up for manure utilization, including very heavy amounts. Ray Miller.

7. Dryland Wheat Studies. Research to remove snow from winter wheat areas by spreading ash over past years has shown this practice to be very beneficial. This practice was commercially applied in 1976. Studies on eroded knolls have shown much of the yield depression can be corrected with proper fertilization. Rex Nielson and Ray Cartee.

8. Solar Energy and Microclimate Research. Studies are underway to determine best sites for future solar energy plants and to determine the possibilities of using solar energy for heating greenhouses, drying crops, etc.

Studies of plant growth limitations because of climatic reasons is being conducted. Also studies are underway to better understand the spring snow melting process to aid in predicting flood danger and spring runoff. Inge Dirmhirn.

9. Atmospheric Dispersion and Mountain Valley Circulations. Wind patterns and atmospheric turbulence transport water vapor, fugitive surface dust, insecticides, and smoke stack effluent through the air. With data taken from free-flying balloons, instrumented towers, and tethered balloon systems, atmospheric scientists are able to measure the winds and the turbulence. From an understanding of the physical forces involved, they can construct mathematical models which predict the movement of water vapor, dust, insecticides, and pollutants, and the concentrations which will occur at a given location and time. Gene Wooldridge.

10. Predicting Climatic Influence on Crop Development. This research has led to the prediction of when to irrigate fruit trees for frost protection and to delay bud development. Similar models have also been developed to predict development of other plants and of insects. Arlo Richardson and Gaylen Ashcroft.

11. Cloud Seeding. This project is a continued assessment of cloud seeding programs and techniques in Utah. Donein cooperation with the Utah Water Research Lab. Ken Hubbard,

SOIL SURVEY RESEARCH ACTIVITIES
WASHINGTON STATE UNIVERSITY

Research Project 0900 Soil Classification and Survey

Objectives:

1. To participate as a contributing member of the National Cooperative Soil Survey in terms of the following agreements: (1) The memorandum of understanding between the Washington Agricultural Experiment Station and the Soil Conservation Service, USDA, 1953, and (2) the personnel contracts and cooperative agreements between the Agricultural Research Center, the Cooperative Extension Service and the State of Washington Department of Natural Resources.

2. To study soils of the State by field and laboratory methods for classification purposes.

3. To develop effective and efficient methods, procedures and techniques for soil survey projects.

4. To establish the behavior of selected soils for different levels of management and for various uses.

5. To publish results, methods, and predictions in bulletins, research articles, and theses.

On-Going Activities Related to Objectives:

1. Benchmark Soil Reports: Shano Series in central irrigated and dryland wheat region of Washington - by Ayuni Hautea (MS program).

2. Geomorphic and Genetic Studies:

a) Kitsap Series in Puget Sound region of Washington. Study covers geographic order, morphology, genesis, behavior with special emphasis on urban uses - by Henry Shovic (Ph.D. program).

b) Chemawa Series in White Salmon - Columbia River region of Washington. Study is concerned with orgin of loess-like parent material of these soils and their morphology by Chris Mack (MS program).

c) Sails of the Manis Mastodon Site in the northeastern part of the Olympic Peninsula, Washington. Study involves characterizing soils and soil materials, determining age by carbon dating, pollen and seed identification as a means of recreating landscape at close of the Pleistocene - by Robert Gavenda (MS program).

3. Behavioral Studies: A statewide study to correlate soil properties and landform features to site index of commercial forest species as a means of estimating forest productivity for the Forest Land Grading Program, by Bruce Ahrendt (MS program).

Publications of Work Completed in 1977:

1. Procedures Handbook: Forest Land Grading Program for State of Washington, 1978.

2. Paper by Don Wysocki Mapping Unit Purity of Selected Glacial Soils of Washington, Symposium on Soil Variability, ASA meetings, 1977 (Unpublished M.S. Thesis, WSU, 1978).

3. Chapter X Forest Soil Survey, Handbook on Soils of Douglas-Fir Region - by R. A. Gilkeson.

Soil Resource Investigations By Agriculture Canada

Keith W.G. Valentine

Western Soil Correlator (Acting), Soil Research Institute, Ottawa

First of all I would like to take this opportunity to thank you for the invitiation to attend your meeting. I have found it very interesting and informative as many of the problems that you are discussing here we are also wrestling with in Canada, I will confine my remarks to significant developments over the last year in Canada, and will try to make them relevant to the discussions I have heard in the past three days.

Perhaps of most significance to our survey operations has been the revision of the Canadian System of Soil Classification. It will be published before the ISSS Congress in Edmonton in June 1978. The main change is the inclusion of a ninth order - the Cryosolic - defined as soils which have permafrost within one metre of the surface (within 2 metres of the surface if they are cryoturbated). While on the subject of classifications, I should mention that we are now using our terrain classification, the Lands Directorate in the Department of the Environment has a mandate to develop and apply our ecological (biophysical) land classification, and some provinces are developing vegetation mapping systems.

Our survey operations, like yours, are facing increasing demands for soil data and a wide variety of interpretations. I will give you a few examples to illustrate the range of work we are attempting. A reconnaissance survey of Newfoundland is underway which combines the two approaches of soil survey and ecological land classification. National Parks are being surveyed in Alberta and British Columbia. Semi-detailed surveys for forest land management are being done in British Columbia, and detailed surveys of the urban-agriculture conflict zone have been done in Ontario and Alberta.

We arc also developing a mapping system to formalize some of our methods and procedures which in the past have been practised by tacit understanding. As our organization grows and our work deals with more and more types of land we find that we need a well defined framework within which to work. But we intend this framwork to be flexible enough to accomodate different survey scales, purposes and formats.

Our soil information system (CanSIS) is now complete and operational. New forms and a new manual have been developed to incorporate our new taxonomy. Data from experimental plots, soil tests, variety trials and forestry plots as well as soil survey pedons are being fed into the data file. The cartographic system is now operational and fully integrated with our cartography unit which drafts the soil maps. We have the capability of digitizing, storing and reproducing the lines and symbols of our soil maps. Acreages can be calculated, and interpretive maps can be produced by associating the interpretation symbols with the soil symbols in the computer and then plotting only the interpretation symbols. This system has taken a long time to develop and has not been without its troubles. We have found it very difficult to keep programmers long. They tend to move quickly to capitalize on valuable experience. Base maps must be prepared carefully so that they fit together within one project, otherwise they cannot be digitized. Our lack of standardzation in soil symbols has caused problems when surveyors have used such things as colons or semi-colons in their symbols, which are also used in the programme of instructions to the computer.

Support research for our survey is another important role within the Research Branch of Agriculture Canada. Work is in progress on the cementing agents in ortstein horizons (some have been found with aluminum-organic matter complexes as the cementing agent), the criteria for argillic horizons, the characterization of standard soil samples from across the country and the use of clay mineralogy in predicting the engineering properties of soils. A reference bibliography of the clay mineralogy of soils and surficial materials in Canada has also been prepared.

In the field of remote sensing a project has been started to define homogeneous land units on satellite imagery. We have found that some crop predictions or land use mapping has been confounded by the heterogeneity of the underlying terrain. The homogeneous land units are designed to provide a uniform land base for future interpretations. There is also a cooperative project between the Environment Research Institute Michigan (ERIM) and the Canada Centre for Remote Sensing (CCRS) to study the effect of surface soil and terrain characteristics on the returning signal of a microwave system. They are using the X and L bands of a 4 band radar system with two polarities.

The Soils of Canada, in two volumes with two maps and a glossary was published in 1977. Our classification system is to be published in 1978, as will the Soil Landscapes of British Columbia which attempts to explain the geographical distribution of the soils in our westernmost province.

Lastly I should like to extend an invitation on behalf of the organizing committee to all of you to attend the International Society of Soil Science Congress in Edmonton from 19 to 27 June 1978. I can assure you we are working hard to make it a very successful meeting and we look forward to seeing many of you there.

WESTERN REGIONAL TECHNICAL WORK PLANNING
CONFERENCE OF THE COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA, FEBRUARY 12-17, 1978

Committee 1 - Soil Survey Operations

Charges

1. Explore ways to revise and modernize technical guides to meet today's needs. Identify the kind of information that can be recalled from our data banks that would be useful. Develop examples of suitable format.

2. Evaluate the effectiveness of various training methods used with new soil scientists, such as on-the-job training by party leader, intensive group training in basic soils.

3. Consider and evaluate advantages gained by mobility programs between states in contrast to mobility within a state in preparing a soil scientist for additional responsibilities. Are summer or winter details an effective substitute for transfers between states? Consider not only experience gained but also cost production factors.

Review

This is a new committee for the West Regional Technical Soil Survey Work Conference. In name, it does not correspond to a National Committee. It does seem to encompass most of the items covered under Committee 1 and 2 of the National Conference and also the old Committees 1 and 2 of the 1976 Conference at Phoenix.

Charge 1 - Explore ways to revise and modernize technical guides to meet todays needs.

Response

It is obvious that the technical guides need modernizing. It requires a joint effort with other professional disciplines to make any significant contribution. We need suggestions from the people who currently use technical guides and find what todays needs are for those who will use the information.

Oregon is using a supplement to the SCS Form 5. It contains a more complete, but still brief, narrative of the series at the beginning. Each mapping unit of the series is named and given a number. For each interpretation on the form the appropriate number is listed and restrictive features are named.

A method for revising technical guides would be to subject them to review by additional qualified people both within and outside the SCS to assure maximum input of research data and knowledge of soil behavior for different uses. There is a great need to develop more information about soil treatments/management, particularly for urban related uses, such as waste disposal, building sites, etc. It is not enough only to indicate the degree of limitations and suitabilities. We need to develop recommendations for feasible treatments that will alleviate the problems and ensure adequate performance of different soils. Some of this information will have to be derived from research but much can be gained by documenting successful local experience and methods used to overcome limitations on different kinds of soils. General costs should be a part of the information collected.

Another point of emphasis is the need to assure that records are kept of background information used in developing the recommendations. Only by this means can a determination be made at any point in time that all pertinent information has been considered.

Related to acquisition of supporting data is the need for continuing effort to ensure that pertinent research is conducted on important soils and on representative, properly identified sites of these soils.

It is possible that the soils section of Technical Guides could be organized and prepared, in part by programming the computer to output information on all soils known to a given Soil Conservation District, County, Resource Area, or any other work unit from which soil resource planning is done.

California's tech guides were modernized two years ago to incorporate the other two quality missions. provide a more meaningful format, and incorporate new material. Revisions and modernization of tech guides is really a major effort requiring large time inputs from State and Area specialists, AC's, DC'S, etc.

We should devote our time to getting soils information into the tech guides, using the existing procedures. We need to expedite the production of Form 5's and the related tables. We need to get these to our DC's. We also need to be sure they know how to adapt the information for their field offices.

What we do not need is more changes at this time - especially things that will affect production I" soil survey offices and field offices. Soils procedures have undergone a lot of change in the last several years. We need time now to settle down and absorb these changes. Our problem now is training our employees to utilize what we already have. we can forego "improvements" at this time if it's going to cost us production. Wc very badly need those surveys now.

Recommendations

If is recommended that the TSC investigate the kind of form that can be generated from the data bank which would supply needed interpretative data on single mapping units. Send example of this form to states for their review.

It is recommended that investigation be made on ways to set up trial forms to document practices to overcome limitations, cost input data, and performance records.

Charge 2 - Evaluate the effectiveness of various training methods used with new sail scientists.

Response

Most of the training of new soil scientists must be on-the-job under supervision of survey party leader. All of us vary in our skills for different tasks and party leaders will differ I" their effectiveness to carry out training objectives. Several possibilities occur for enhancing the effectiveness of the training received.

1. Develop guidelines for party leaders that would point out effective training techniques; emphasize the different aspects of soil survey that the training should include (for example, field mapping techniques, descriptions and legend development, geomorphic interpretation of soil landscapes. soil interpretations,

5. Group training in basic soils is very helpful. Our Soil Science Institute, Soil Correlation Training, Soil Mechanics courses, etc., are all very helpful. I do believe we need a training session (very early in a soil scientist's

career) on "Soil Mapping Techniques." A training session such as this could give insight on use of tools (soil reagents, salt bridges, calcium carbonate kits, Hach kits, etc.), photo interpretation, methods of mapping (and reasons for) at different intensities, mapping the woods versus mapping in the irrigated cropland or desert range type areas.

6. Intensive or group training similar to those courses held in Portland for correlation should be used to supplement on-the-job training. These could be in any specialized phase of the soil scientists' position. An orientation course for newer employees would take some of the training load off the party leader. 'This course could cover some of the basic soil science activities. If could provide specialists in various phases to do the teaching. It could give some assurance that people are getting uniform and quality training and were ready to perform many activities with a minimum of guidance.

7. One state is presently implementing a number of changes in its training program for the lst-year professional. These changes flow out of a rather comprehensive review of the training policies and procedures. They are establishing a training center for new professional employees. The purpose of the center will be to provide one month of training at a central location in the orientation subjects - personnel. defensive driving, the career system. SCS history, etc. An overview of RCD (SCD) activities, and conservation planning and application will also be covered. These are the subjects that are needed by all new employees, regardless of discipline. This type of training can be given more efficiently and effectively in this manner and will help relieve the training workloads at our field location.

8. We cannot afford to think in terms of a one year training period for new professionals any longer. Party leaders have a tendency to underrate our new people. They need to be challenged - not held back. We should have a production employee in six months after the start of the training center approach, without any lowering of our quality.

Recommendations

It is recommended that on the job training be continued as the primary source of training for new soil scientists. and guidelines be developed to train individuals through various proficiency levels.

It is recommended that group training be given on basic items such as photo identification, mapping techniques on the different orders of surveys, remote sensing. soil-vegetation relationships, etc.

Charge 3 - Consider and evaluate advantages gained by mobility programs between states in contrast to mobility within a state in preparing a soil scientist for additional responsibilities.

Response

Summer or winter details are valuable training devices. They broaden the experiences of the soil scientist and give him new insights to his work. However, they are not equivalent in value to transfers between states...either from the standpoint of experience gained or in terms of production. Details are of relatively short duration and do not provide time to learn many of the technical facts and operation items that are available to he learned in the new area. Transfers. on the other hand, do usually provide adequate time to get well acquainted with the survey area, both technically and operationally. Similarly, details often end up with disappointing production figures because of the time it takes to get acquainted with the new area. This varies, of course, with the person, the complexity of the survey area. the length of detail, etc.

Summer or winter details or other short term assignments will broaden the experience of the individual. These assignments are usually made to accomplish specific objectives. The need is for an experienced person who can get acquainted with a new area rapidly end do a production job in

Short term assignments should be evaluated carefully. Eve" though they can provide valuable experience they may cause morale problems and eventually the "trained" employee finds a stable and more rewarding situation elsewhere. The transfer should have some assurance of upward mobility.

Up thru the GS-11 level, there is no advantage in moving soil scientists between states. Most employees advance to the CS-9 level so rapidly now that the problem is training them in the basics before they become party leaders. There's a lot to learn beside the sails. To be effective at the GS-9 level and above, they need to learn administrative and management skills. To get much of this, you need to be in one job at one location for several years. You have to have time to live with the results of your decisions and learn there-from.

For GS-12's, there are advantages to multi-state experience. At this level, you are operating at a state level and usually have some administrative responsibilities. However, I see nothing wrong with selecting a GS-12 specialist or Assistant State Soil Scientist from within the state. If so selected. they probably should lateral to another state before they become State Soil Scientists. It takes this kind of experience to broaden the viewpoint of most individuals to the extent necessary for performance at the GS-13 level.

Recommendations

It is recommended that details between states be looked at closely in relation to experience gained versus cost. The length of detail has to be long enough to be beneficial, both in terms of experience gained and production given.

It is recommended that a list be compiled and maintained. at the National level, of soil scientists available for detail - also time of year the individual would be available.

COMMITTEE 1 MEMBERS

R. Fenwick - Chairman
G. Simonson
G. Kennedy
E. Brown
R. Mitchell
H. Waugh
R. Mayko
R. Flenner
R. Montgomery
c. Logan

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Soil Survey Publications
Committee 2

The following charges were given to the committee:

1. Explore whether wildlife interpretations should be made at a taxa level or be treated in the descriptive material of a general soils map.

2. National committee has charged each Regional committee to develop a soil formation section for a selected MLRA to be used as a guide. Develop one or more examples to be used as guides in preparing this section. If a really good soil formation section already exists, it can be used.

3. Evaluate and comment upon the map compilation procedures now in use. Practical alternatives to be listed.

Charge 1 Discussion:

In recent years wildlife interpretations have been made at the taxonomic unit level. These have been prepared primarily by using the SCS-SOILS-5, Soil Interpretations Record form. SOILS MEMORANDUM-74 sets forth the policy for developing the soil interpretations for wildlife habitat. There has been considerable concern by biologists and soil scientists that this approach was not adequate in the western states.

TSC Advisory SOILS-PO-18 (September 7, 1977) proposed changes to the guides for making wildlife interpretations. This advisory was circulated to all the western states and the other technical centers for review and comment. The comments varied from "a good revision" to "needs a rewrite for a major overhaul of rating for wildlife suitability." Some reviewers felt the information was too general for planning specific sites. Others felt that we should delete ratings for named soils, but develop wildlife potential ratings for broad landscape units. The members of Committee 2 had about the same range of opinions on how the wildlife interpretations should be prepared.

A rewrite of the guide for making soil interpretations for wildlife is being considered by a western region Soils-Wildlife task force. The task force has a tentative date of March 27, 1978, to review the recommendations. Presently the committee plans to modify the guide to prepare interpretations for wildlife on the broad landscape unit basis. The habitat element names will be changed to agree with the proposed USGS Land Use Classification. This scheme is being utilized in land stat studies and provides for greater utility in our interpretations.

Recommendations:

1. This conference gives its support to the WTSC Soils-Wildlife Interpretations task force to complete the interdisciplinary revision and review of proposed policy changes.

2. Soils-Wildlife interpretations should be developed for broad landscape units.

Charge 2 Discussion:

Committee 1 of the 1976 Western Regional Technical Work-Planning conference presented three samples of different ways of preparing this section, but not in MLRA format.

The committee thinks there have been several good soil formation sections written. Dr. Roger B. Parsons has prepared a soil formation section for Multnomah County, Oregon. In this section soil-forming factors of climate and living organisms are discussed separately. Factors of time, topography, and parent material are grouped and discussed under the heading "Geomorphic Surfaces and Soil Development." This area has a relatively large amount of literature available.

The Soil Survey of Yolo County, California, has a section prepared by Grant M. Kennedy. This section ties all the soil forming factors together rather than discussing each factor separately.

The Soil Survey of Eastern Fresno Area, California, has a section prepared by Dr. Gordon Huntington. This section is more traditional, but does a good job of relating the soil forming factors to the soils of the area.

The Reconnaissance Soil Survey of Railroad "alley Area, Nevada, has a discussion of soil formation BE a part of the general soil map section. This soil formation section was prepared by Dr. Fred Peterson.

Recommendations:

1. The first draft of the soil formation section should be written early in the survey.

2. The soil formation section by MLRA is not suitable for the western states.

3. A discussion of soil formation by sail-landscape relationships should be an option.

4. Several samples of good soil formation sections should be included in the National Soils Handbook.

5. Canned sail formation sections are not appropriate.

Charge 3 Discussion:

Several topics that affect the quality of the soil maps in our published soil surveys are listed below:

1. Review present status of quads that are of questionable accuracy -

   Recently USGS advised us that many of the quads we have ordered, but not cost-shared in, do not meet our accuracy requirements. These quads would cost SCS between $28 - $34 each. The main problem with the quads is image displacement up to 200' at 1:24,000 scale and double images. If we reject these quads they would have to

   Carto believes many of the quads could be used as they presently are. We propose Carto and the states jointly review the questionable quads.

2.

   Dr. Klaus Flach has expressed concern over the cost of publication imagery in the western states. Orthophoto and mosaic imagery costs are disproportionately higher than imagery costs for other parts of U. S. He believes we should make more use of line maps for some of our smaller scale publications.

   There may be some alternatives to preparing mosaics by splicing adjoining photos but this could require using non-standard sheet formats.

3.

4.

5. NCSS map finishing contracting.

   a. Since states will normally want to contract out one survey area at a time, the costs may be higher than when several areas are contracted.

b. The diversity of services desired between states makes it difficult if not impossible for Carto to prepare standard specifications, i.e., drafting versus compilation and drafting.

c. Work contracted must be contracted in accordance with contract and procurement policy. Individual state office personnel should be involved and will have final authority for contracting, not Carto personnel. Carto will provide technical guidance.

A local contractor may not always be the lowest bidder

6. Map "rafting Problems -

The greatest single problem in map drafting by the states is the opacity and uniformity of inked line wrights. Much of the problem is due to finding the right combination of (a) drafting film, (b) drafting equipment, and (c) individual skill.

One state, Utah, has found that a drafting film they can acquire locally is superior to that which Carto provides and obtains through GSA schedule.

Cart" encourages states to investigate new materials on their own but counsel with Carto before using the new item extensively. It may not be suitable far some other reason.

7. Some states have experimented with scribing as an alternative to drafting. California and New Mexico are two states that have tried scribing.

Recommendations:

1. Imagery in publication format should be ordered for the beginning of a soil survey.
2. The various options of base imagery should be considered for each survey area and the most desirable option selected.
3. Nap finishing should be done at the cartographic unit to achieve desired quality control and cost benefits.

The committee developed an additional charge.

Charge 4:

Explore whether the present format of published soil surveys is adequate for all soil surveys.

Discussion:

The Soil survey of San Diego, California, is an example of a soil survey that is not in standard formal, but has special needs by the primary users.

Recommendation:

The standard publication format of published soil surveys should not be required where the soil survey area is under the control of a public land management agency or where major users have a special need. The publication format should be flexible. but should have a minimum standard that includes the classification of the soils.

The report of the committee was approved and accepted by the conference.

D. Pease, Chairman	R. Kover
R. Parsons	R. Hoppes
D. Stelling	F. Peterson
R. Dansdill	R. Richardson
K. Thomas	P. Singleton
T. Collins	

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Improving Soil Survey Techniques
Committee 3

The following charges were given to this committee:

1. Explore procedures and techniques for supplementing order 3, 4, and 5 soil surveys and prepare guidelines.

2. Consider ways of improving soil series descriptions such as use of tabular display for section on range of characteristics, block description, etc.

3. Evaluate end comment on the various procedures and techniques used to determine the composition of soil mapping units.

Charge 1 - Procedures and Techniques

The Revised Soil Survey Manual, as proposed in the fifth draft, pretty well describes the five orders of soil survey and their uses. There are basic guidelines on map scale, minimum sire for mapping unit delineations, mapping unit purity and allowable inclusions. The field methods or procedures are also dcscribed.

Since soil surveys of any order, 1 through 5, are by definition soil surveys. the guidelines and techniques that are published in the "National Soils Handbook: end various SCS memos also apply. It would seem, then, that the existing guidelines and techniques are sufficient, telling us basically what and how, but allowing latitude to design the soil survey to fit the situation.

There is, however, one procedure in sail survey where there are few or no guidelines. That procedure is mapping unit delineation, Other then general sire of the unit, there are no specific, published guidelines or criteria that help the mapper decide just how to delineate a mapping unit on an aerial photograph that represents a logical soil unit on the ground. There are no boundary or line determinant criteria.

In order 1 soil surveys, the mapping unit boundary determinant criteria are primarily soil characteristics alone. These order 1 mapping units are perhaps the easiest for a sail scientist to delineate because it takes little imagination and lots of hole digging. It take little knowledge about soil and landscape relationships.

Progressing through orders 2, 3, 4, and 5 soil surveys, there is decreasing dependence on soil characteristics as line determinant criteria and a,, increasing dependence on landscape characteristics. Thus, mapping unit delineations in an order 5 survey are based almost entirely on non-soil characteristics.

The fallowing chart illustrates the primary line determinants for mapping unit delineations for the 5 orders of soil survey. This chart is intended to be illustrative and is not all inclusive.

	SOIL SURVEY ORDERS				
	5	4	3	2	1
LANDFORM					
Erosional vs. Depositional	X	X			
Node of Frosion or Deposition		X	X		
Specific Landform			X	X	
LITHOLOGY					
Texture & Chemistry	X	X	X		
Rock Type			X	X	
VEGETATION					
Physiognomy	X	X	X		
Species			X	X	
SOIL				X	X

X = Primary line determinant

As the above chart indicates, soil is not one of the primary line determinants in delineating napping units for orders 3, 4, and 5 soil surveys. This does not mean these higher orders of surveys are not soil surveys. After the unit is delineated, the soils within each delineation are Identified and described within prescribed standards.

Each mapping soil scientist, especially those working on the higher orders of surveys, must have a working knowledge of the landscape (geology, geomorphology, and vegetation) and its relationship to the soil. It is this relationship that is used as the criteria to delineate soil mapping units. It was ststed earlier that soil mapping unit delineation is an art that is acquired through experience, assuming the ability is present. Experience can be accelerated by training.

Recommendations, Charge 1

1. For each sail survey area, and particularly for order 3, 4 and 5 surveys, persons with a good working knowledge of soil, vegetation, and landscape relationships should help set up mapping units and establish delineation criteria. For instance, a geomorphologist, range conservationist, and/or forester may be assigned to work with a survey team at the beginning of a survey.

2. The mapping unit criteria far a given soil survey area, as developed through recommendation 1, should be part of the Soil Survey Handbook.

3. Each field soil scientist should be given training in soil and landscape (geomorphology, vegetation, petrology, etc.) relationships.

4. Party leaders and party leader candidates be given in-depth training in the mechanics of soil survey--how to see it up, mapping unit design, etc.

5. Students majoring in soil science, especially those intending to seek employment as soil surveyors (pedologists), should be encouraged to rake courses in geomorphology, petrology, and plant ecology. Action should also be taken to require these courses for a bachelor's degree.

6. Remote imagery (including aerial photographs) and its use should be give" equal status with survey staffing.

Charge 2 - Series Descriptions

Apparently the West Technical Service Center has also bee" working on this committee's charge 2. They have developed a format that displays the range of characteristics in a table form. This format should make it easier to compare one series with another and a new or unknown soil with a" existing series.

Additional comments that were considered during this committee's work regarding series descriptions are as follows:

Delete the section "Geographically Associated Soils". This kind of information belongs in the map unit descriptions and is superfluous to the characteristics and classification of the series.

A short section headed "Diagnostic Horizons" could be added to the series description. As a" example, a Typic Calcixeroll could have a mollic epipedon, cambic horizon and calcic horizon listed. This might also benefit soil scientists who rarely, if ever, get to see some kinds of horizons.

The weakest part of the official series description is the section on "Drainage and Permeability" which includes runoff. Many descriptions range runoff from slow to very rapid. This is meaningless without qualification. The hydrologic soil group for the series should be indicated in this section and the rating for runoff be dropped. All series have bee" assigned to a hydrologic soil group and are correlated nationally.

The present drainage classes used in the official series descriptions are not interpreted consistently by different people. I suggest that if these drainage classes are used, they should be supplemented by such statements as never saturated, saturated for a few days. or a few weeks, or saturated for 3 or 4 months during winter and spring, etc. Also. depth to water table, duration, and seasonal fluctuation could be described. This would provide a better indication of how wet a soil really is and its probable effect on soil "se and management.

Listing of colors should be eliminated from the range in characteristics. The entire range--value and chroma--is not necessary. Only the major color(s) and hue(s) (reddish brow" or brown in hue 5YR through 10YR) are needed. Values and chromas of mollisols need only be stated less than 5.5 dry and 3.5 moist.

List major plants by name. Don't say grass and woodland - specify kind of grass and kinds of trees. Also, if irrigated, list the major crops grown.

List scientific plant names after common names. I have see" two completely different plants with the same common name--both plants from different states.

Give pH notations (7.8, 5.5 or 7.0) in each horizon. Medium acid. slightly acid or moderately alkaline is not always clear or understood,

Have the introductory paragraph of series descriptions and the introductory paragraph of the SCS-SOILS-5, Interpretive Data Sheer, the same.

Elaborate a little more on the setting - pinpoint the position (aspect, etc.) of the soil on the landscape a little better. Use geomorphic terms more.

Recommendations - Charge 2

1. All new series descriptions and newly revised series descriptions be written in a format that displays the range in characteristics in tabular form. The format illustrated by Exhibit 1 is recommended.

2. Taxonomic justification should not be used in the range of characteristics unless it is needed to refine the series placement at the family level.

3. Describe the setting in geomorphic terms (aspect, slope position, landform, etc.) that would help the reader picture the soil on the landscape.

4. A portion of Form 5 (estimated properties and vegetation) be combined with the series description into one document--the Soil Series Description. This is illustrated in Exhibit I.

Charge 3 - Composition of Mapping Units

The Committee 7 Report, to the 1975 National Soil Survey Technical Work-Planning Conference, identifies and outlines the procedures for determining mapping unit composition. The Committee 7 Report discussed transect, traverse, observation, and interpretation of remotely sensed data. To further define some of these procedures, the following is offered.

Transects. Predetermined routes of travel across the landscape. The routes are generally, but not necessarily, straight lines, chosen either randomly or selected non-randomly in order to obtain the most useful information with the least effort. Detailed observations are usually made at selected points along a transect. These points must be predetermined only if the data are to be analyzed statistically. A grid pattern may be developed by selecting parallel transects with a fixed spacing and making observations at regular intervals along the transects. The purposes of transects in soils inventory are (1) to identify pedons and determine map units components, (2) to discover the patterns of polypedons in relation to landforms, lithology, vegetative cover, and other landscape features in order that these can be used in the recognition and delineation of map units, and (3) to check the accuracy of map unit descriptions and evaluate taxonomic and/or map unit variability.

Traverses. Irregular routes of travel across the landscape. A general route may be chosen in advance, hut the actual path is left to the whims of the traveler and may be changed or reversed anywhere along the route if the objective is changed or accomplished. Although observations are made along a traverse, some are more detailed than others. The more detailed observations may be in cut banks, at auger holes. or in pits. The purposes are (1) to identify pedons and determine map unit components and (2) to discover the patterns of polypedons in relation to landforms, lithology, vegetative cover, and other landscape features in order that these can be used in the recognition and delineation of nap units.

Spot Checks (Observation). Observation of soils and other landscape features at a site, or from a site. Spot checks are most common in inventories of large areas where much walking is impractical. In walking between spot checks. the spot checks become detailed

Transecting is used primarily on Order 1 soil surveys and to a lesser extent on Order 2 surveys. Transecting is also used on any surveys in areas where soil patterns cannot be related to something identifiable on aerial photos.

Observations are used to some extent on all surveys but are most predominantly used on Orders 3, 4, and 5 surveys.

	ORDER OF SOIL SURVEY				
	1	2	3	4	5
Transect	X	⊗			
Traverse		X	X	⊗	
Observation		⊗	X	X	⊗
Photo Interpretation		⊗	⊗	X	X

X = Primary Use

⊗ = Secondary Use

To evaluate the four procedures for determining mapping unit composition is something like evaluating a tack hammer and a sledge-hammer. Each of the four procedures are separate tools, though somewhat interchangeable. If used properly, each can accomplish its intended purpose to the specified standard.

Recommendations - Charge 3

1. Emphasize and encourage the use of all appropriate procedures for determining the composition of mapping units.

2. Emphasize the need to take field notes on the mapping units and their characteristics and composition as well as on taxonomic units.

3. During the soil survey review process, spend more time field checking the mapping units.

Committee Membership:

Chairman: J. Anderson
G. Otte
J. Rasmussen
R. Huff
O. Carleton
S. Brownfield
L. Giese
T. Spencer
D. Richmond
A. Ness
P. Derr
D. Hendricks

Established Series
Rev. KKC/GWH
12/77

EXHIBIT 1

DELANO SERIES

Delano soils are deep and well-drained. They occur on alluvial fans, plains and terraces in the east side of the San Joaquin Valley. Elevations range from 300 to 700 feet. Mean annual precipitation is 6 to 9 inches. MAT is 64 F. FFS is 260 to 290 days. The surface layer is brown, sandy loam 11 inches thick. The next layer is brown clay loam or sandy clay loam about 25 inches thick, underlain at 42 inches by light yellowish brown loam or sandy loam. Slopes range from 0 to 9 percent.

Taxonomic Class: Fine-loamy, mixed, thermic Typic Haplargids.

Typical Pedon: Delano sandy loam - cultivated. (Colors are for dry soil unless otherwise noted.)

Ap1--0 to 6 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable. slightly sticky and slightly plastic; common very fine roots; many very fine interstitial and tubular pores; slightly effervescent with disseminated lime: moderately alkaline (pH 8.0); abrupt smooth boundary. (5 to 8 inches thick)

Ap2--6 to 11 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) moist; moderate medium and coarse subangular blocky structure; slightly hard, friable. slightly sticky and slightly plastic: common very fine and few fine roots; many very fine interstitial and tubular pores: strongly effervescent with disseminated lime; moderately alkaline (pH 8.0); abrupt wavy boundary. (5 to 18 inches thick)

B21tca--11 to 22 inches; light brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) moist: moderate medium prismatic structure parting to moderate medium angular blocky; hard. firm, sticky and plastic; common very fine roots; few very fine interstitial and common very fine tubular pores; continuous moderately thick clay films on faces of peds and in pores; violently effervescent, lime segregated in common irregular fine filaments or threads; moderately alkaline (pH 8.0); abrupt wavy boundary. (6 to 15 inches thick)

B22tca--22 to 36 inches; light brow, (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) moist; strong coarse prismatic structure parting to moderate coarse subangular blocky; very hard, very firm, slightly sticky and plastic; common very fine roots; common very fine interstitial and tubular pores; many moderately thick clay films on faces of peds and in pores; violently effervescent, lime segregated in common irregular fine filaments and in seams; moderately alkaline (pH 8.0); abrupt smooth boundary. (10 to 20 inches thick)

B3tca--36 to 42 inches; light brown (7.5YR 6/4) heavy sandy loam, dark brown (7.5YR 4/4) moist; moderate coarse and medium subangular blocky structure; hard, firm, slightly sticky and plastic; common very fine roots; common very fine interstitial and tubular pores; common moderately thick clay films an faces of peds and in pores; violently effervescent, lime segregated in common irregular fine filaments or threads; moderately alkaline (pH 8.0); abrupt smooth boundary. (0 to 10 inches thick)

C--42 to 63 inches; light yellowish brown (10YR 6/4) ay loam,s;

Range in Characteristics:

Soil moisture (between depths of 4 and 12 inches)	dry from mid-April to January; moist in some parts > 90 days in winter
Soil temperature	64° - 67° F.
Rock fragments	0-5%, < 1/2" diameter
Ap horizon	
dry color	10YR 6/3, 6/4, 6/3, 5/4
moist color	10YR 4/3, 4/4, 3/3, 3/4
texture	sl, l (10-27% clay)
organic matter	< 1%, decreases regularly
reaction	mildly alkaline - moderately alkaline
carbonates	generally disseminated, absent in some pedons
B2t horizon	
dry color	10YR 6/4, 6/3, 5/4, 5/3; 7.5YR 6/4, 5/6, 5/4
moist color	10YR 4/3, 4/4; 7.5YR 5/4, 4/4
texture	l, cl, scl (20-35% clay)
carbonates	segregated filaments, seams, soft masses
C horizon	
dry color	10YR 7/3, 6/4, 6/3, 5/3
moist color	10YR 5/3, 5/4, 4/3
texture	sl, l (10-27% clay)

Competing Series: These are the Cuyama and Tejon series in the same family and the Adelanto, Milham, and Neuralia series. Cuyama and Tejon soils are assumed to have gravelly or cobbly material in the lower part of the profile (see Remarks). Adelanto soils have a coarse-loamy control section. Milham and Neuralia soils are moist in all parts of the moisture control section for less than 60 days in the winter.

Geographically Associated Soils: These are the Exeter, Panoche, and Wasco soils. Panoche soils lack a Bt horizon. Wasco soils lack a Bt horizon and are coarse-loamy. Exeter soils have a duripan.

Use: Used mainly for growing irrigated citrus, fruits, nuts, and row crops.

Distribution and Extent: Mainly in the southeastern part of the San Joaquin Valley. They are not extensive.

Series Established: Upper San Joaquin Valley, California Reconnaissance, 1948.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-11	L	ML	A-4	0	100	95-100	70-90	50-65	25-35	NP-10
0-11	SL	SM, SM-SC	A-2, A-4	0	100	95-100	50-60	30-50	20-30	NP-10
11-42	CL, SCL, L	CL	A-6	0	100	95-100	75-100	50-70	20-40	10-20
42-63	SL, L	SM, ML	A-2, A-4	0	100	95-100	50-75	30-65	20-35	NP-10

DEPTH (IN.)	CLAY (PCT 2MM)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	15-27		0.6-2.0	0.14-0.16	7.4-8.4	<2	LOW	.37	5	-	<1	HIGH	LOW
0-11	10-20		2.0-6.0	0.09-0.12	7.4-9.4	<2	LOW	.28	5	-	<1		
11-42	20-35		0.2-0.6	0.14-0.18	7.9-8.4	<2	MODERATE	.32					
42-63	10-27		0.6-2.0	0.09-0.16	7.9-8.4	<2	LOW	.28					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

Remarks: The Cuyama and Tejon are established series but have not been used since the Bakersfield Soil Survey Report (1937) and the Wasco Soil Survey Report (1936). Since there is considerable overlap with the Delano, Milham, and other series they probably should be made inactive.

National Cooperative Soil Survey, U. S. A.

WESTERN REGIONAL TECHNICAL WORK-PLANNING
CONFERENCE FOR SOILS SURVEYS

FEBRUARY 13-17, 1978, SAN DIEGO, CALIFORNIA

Committee 4 - Soil Survey Interpretations

Charges

1. Evaluate present methods and identify new means for making useful interpretations of multitara map units.

2. Evaluate and comment on soil-mass wasting ratings. Develop rating criteria.

3. Prepare a guide on how to develop potentials for crop and non-crop interpretations. Prepare list showing kind of soil information required and rating criteria.

4. Develop guidelines and examples of soil survey interpretations for different orders of soil survey.

Charge 1 - Present methods for making interpretations of broadly defined map units appear to be working well, but this is not to say there cannot be improvements made to increase their usefulness.

1. It is imperative the soil survey area work plan specifically spell out the intent and objectives of the soil survey. The objectives can then be used to determine the minimum size management unit, the order of survey, and the interpretations needed to meet these objectives. The actual design of the map units must be multidisciplinary requiring inputs from technical personnel in all fields concerned in the use, management needs, and interpretations needed to meet the objectives of the survey.

2. It is also imperative the broadly defined map unit description be clear, concise. accurate, and complete. This must include the setting of the map unit, its components and their proportion, the components position on the landscape, map unit inclusions, and use and management needs of the map unit and/or each component to meet the objectives of the survey.

3. Management needs and interpretations for complexes and undifferentiated groups described in map unit descriptions to meet the objectives of the survey must be for the map unit and not for the individual components. This is not to say that the effects of the limiting soil property or properties of each component will not be discussed. They must be discussed in order to assess the interactions of the components and their limiting soil property or properties and resultant management needs and interpretations. Normal tabular displays containing interpretations generated from X-Soils-5 forms will continue to be by individual components of the map units. Tabular displays of soil potential interpretations. whether they be for woodland, rangeland, etc., will be presented by map units.

   Management needs and interpretations for associations described in map unit descriptions to meet the objectives must be for the individual component. They should also be discussed for the map unit.

   Normal tabular displays containing interpretations generated from SCS-Soils-5 forms will continue to be by individual components of the map units. Tabular displays of soil potential interpretations will be presented by map units.

   It must be pointed out descriptions of broadly defined map units need not include discussions, nor tabular displays of management needs and interpretations of possible uses that are clearly beyond the objectives of the survey. The tabular displays, however, can be used as backup interpretative data, but the individual interpretations must be screened to determine its usefulness.

   To meet this objective, the committee recommends combination tables be generated as needed from SCS-Soils-5 form data rather than those presently used. For example, a single table could be generated for a" extensive rangeland survey area with a limited Population containing column headings Of septic tank absorption fields, dwellings without basements, local roads and streets, camp areas. and paths and trails. This will combine three tables (one with a single column and two with two columns each) into a single table.

4. It is becoming increasingly apparent additional interpretations must be made to meet the needs of our cooperators and their managers and users. These interpretations are presently being made for in-house documents, some with definitive criteria and others with only general criteria. The primary point is there is no vehicle for recording and coordinating these interpretations regardless of who may make and use them.

   It is further recognized that many of the interpretations presently recorded and coordinated on the Xi-Soils-5 form are not needed, nor used by our cooperators in their in-house documents, nor ultimate publication in the regular soil survey series.

   The committee recommends a new form (SCS-Soils-5A) be prepared and adopted for use by all agencies making soil surveys. It can be used in addition to, or in lieu of the present XX-Soils-5 form. Its use will be predicated on the needs Of the individual agency. It is also our recommendation definitive criteria be established by joint committee action of interagency disciplines for all interpretations recorded on the proposed form.

   These recommendations will serve several purposes, many of which are obvious. The most important, however, are like interpretations for the same named kind of soil and similar named kinds of soil, and a vehicle for inexpensive tabular displays regardless of the type of document prepared.

5. The Committee again recommends that a more detailed "How the survey was made" section be prepared, more thoroughly describing field procedures, being more specific about sampling rates, and addressing specifically the 'statistical reliability" of soil maps and interpretations.

   Present sections are geared to consociation and complex map units. In soil survey areas of mixed order 2 and 3 surveys, and in areas of order 3, 4, and 5, this weakness becomes acute. Phrases such as, "degree of precision" or "degree of reliability" to describe the method Of mapping or interpretations cannot be tolerated.

   The following is offered as only a start for this Section:

   "This survey was mapped at two levels of intensity. The more detailed survey is identified by narrowly defined map units. The less detailed portion is identified by broadly defined units. I" the narrowly defined units, the soil delineation boundaries were plotted and verified at closely spaced intervals. In the broadly defined units, the soil delineation boundaries were plotted and verified by some observations. The intensity of mapping selected was based on the anticipated long term use of the survey, and the map units were designed to meet the needs for that use."

Charge 2

1. Soil mass wasting, also referred to as slope stability or mass movement, include at least six types of soil movement: debris flow, debris avalanche, debris slide, slump, soil fall, and rock fall. However, only landslides (debris avalanches and debris slides) and earth flows (debris flows) may be of mappable size. The small amount of rack fall is the dominant method of movement during summer months. Soil fall occurs along the cutbanks of the second- and third-order streams. Slumps, although of small extent, are locally important to soil "se and management.

   Except for soil fall and rock fall, the types of mass movement are generally correlated to a period of soil saturation by some means, whether rainfall, snow melt, or a ground water table.

Much has been written about soil mass wasting, mostly by geologists and engineers. Unfortunately, most of these publications do not relate to specific soil morphological properties that can be, and are, causes of many of these events. It is admitted there are events that are not soil related and clearly beyond the expertise of a soil Scientist. These we should not address.

Little ha5 been published by soil scientists that directly relate soil mass wasting, it5 causes and effects, to named kinds of soils. There has also been few soil mass wasting interpretations made. These have been based on observations of slope failures and related to named kinds of soil and similar soils, and so defined. This method of making the interpretation is valid insofar as the survey area is concerned but cannot be expanded to other areas in many instances. There are some known named soils, however, that have a high potential for failure regardless of what survey area they may occur in.

Soil mass wasting is one of the normal geologic processes of mountain landscape evolution. A rudimentary understanding of this process can be obtained by a knowledge of the geomorphic surfaces recognized in mountainous terrane as these represent an episode of landscape development. Knowledge of geomorphic surfaces and the soils contained therein will enable the field soil scientist to become familiar with active slopes, metastable slopes, and stables slopes and relate to the possibility of soil mass wasting.

Active slopes have steep and very steep slope gradients and can occur in first-order stream valleys and on the lower slopes of many second- and third-order stream valleys. Movement of material down these slopes may be visible during high intensity storm events. Accumulation of debris on the upslope side of tree stumps and blowdown show the amount of downslope transportation of material and is evidence of the dynamic nature of this surface. The dominant form of soil mass wasting is probably rock fall. Soils on these slopes lack development other than organic matter accumulations. contain appreciable amounts of rock fragments, and usually have bedrock at shallow or moderate depths.

Metastable slopes are usually long with strongly sloping to steep gradients. They appear to be relatively stable under the present vegetative cover. It is reasonable to assume that some materials move down these slopes when undisturbed, but the magnitude and/or rate of the movement is inconspicuous. Metastable slopes are usually associated with first-order stream valleys, but may also occur above active slopes in second- and third-order stream valleys. Soils on these slopes usually exhibit weak or moderate soil development, lack appreciable amounts of rock fragments, and have bedrock at depth5 greater than 40 inches. It is also not uncommon for these soils to have one or more unconformities within the profile.

Stable slopes are usually small in size and scattered throughout mountains. Soils on these slopes are often strongly developed having thick argillic horizon5 of clay textures, lack rock fragments except possible weathered remnants, and are very deep over saprolite.

Soil mass wasting is a result of a complex interaction of several factors in addition to gravity. Soil shear strength, soil depth, slope gradient, soil saturation, and tree root strength are probably the most important. No one of these factor5 by itself can be considered dominant.

The stability of soil on natural slopes or in cut slopes depend5 directly on shear strength or resistance to sliding. The shear strength of one soil may be very different from that of another soil. In the same soil, strength may vary considerably with depth, with structural disturbance, or with seasonal changes in such natural conditions as ground water level, moisture content, capillary saturation, and seepage.

Shear strength is dependent on several factors: particle size and shape, cohesion, adhesion, and tensile strength. Soils are normally an admixture of many particles of varying sizes and shapes. Coarse grained soils consist of variable sized particles with bulky irregular or rounded shapes. Each particle functions individually in the soil framework. The irregular or rounded shape of the coarse particle5 provide many opportunities for contact over very small areas that are virgually point contact. Total void volume seldom exceed5 volume of solids.

Fine grained soils are less than 0.047 mm in size and include clay. The properties of clay often dominate or control the behavior of soils with mixed particle sizes. In natural soils, clays are mostly composed of secondary minerals. The crystalline structure of most of these minerals is such as to create plains of weakness in the particles; hence, the fracturing and breakage that occurs during weathering and transportation often produce plate-like fragments. This may have significance in connection with structural arrangement of soil particles, soil compressibility, and probably has direct bearing on minimum void-ratio values.

Cohesion is the property that causes soil properties to stick together. Cohesionless soils are the coarser soils consisting of nonplastic silts, sand. and gravel that are influenced primarily by gravitational forces, and forces due to seepage and boundary loading. Their shear strength is dependent upon normal loading. Adhesion is the property of interlocking or uniting of clay and other soil particles at a common surface to resist sliding past one another.

Soil depth can be related to normal loading. Deep soils are heavier than shallower soils because of the greater weight at their base. Hence they are more stable as their weight has exerted more interlocking forces that aid in resisting shear failure.

Slope gradient can be related to gravitational forces that tend to pull a soil mass downslope. The steeper the slope gradient, the greater is the gravitational forces available for pulling the soil mass down slope. To counteract these forces, the soil must rely on its inherent frictional forces that is dependent on its in-place density and interlocking of the soil particles. However, it must be remembered that strength is lost once a soil mass is distrupted; thereafter only sliding friction remains to counteract gravitational forces.

Soil saturation as used in this discussion pertains to a period of time, whether hours, days or months, when the soil profile or some included horizon is saturated with water. Probably the most common occurrence is that which is related to ground water and its fluctuations as a result of rainfall or melting snow. Other occurrences may be related to soil morphological properties, namely pore size changes that prevent or restrict normal downward water movement. Pore size changes in a soil profile may be a result of cementation, translocation of clay-sized minerals. abrupt textural changes, shrink-swell properties of clays, lithologic discontinuities, etc. These can and will perch water within the soil until pore water pressures become equalized and draining occurs. Another occurrence is the presence of unweathered bedrock immediately underlying the soil profile. This is of particular importance if the soil occurs on the dip slope of the bedrock. The latter two occurrences are of particular importance in those areas whose rainfall or snow melt water totals are in excess of the available water capacity of the soil. Individual storm events or a rapid sequence of storm events may also create perched water tables.

It is common knowledge that the shearing strength of a clay soil varies widely with its water content. A clay that is at, or near, its liquid limit has very little if any measurable strength, whereas at lower moisture contents the same clay may have considerable strength and bearing capacity. This is a result of a reduction of interlocking forces that hold soil grains together.

Tree roots, or grass and shrub roots to some extent, provide a reinforcing network that can provide a degree of stability to the soil mantle by their anchoring affect to fractured bedrock and rock fragments. This network of roots will also increase cohesional forces of the soil , especially where debris avalanches or debris flows are a problem.

From this very general discussion it can be determined making meaningful soil mass wasting ratings is not an easy task. Such a rating must be based upon interaction between various soil properties. It cannot be based on a single soil property alone. For example a very steep, deep, gravelly loamy coarse sand over granitic saprolite can be very unstable. Conversely a saturated clay with a water table at the soil surface tan be very stable if the slope is less than 2 percent.

If a rating system based upon interactions of soil properties is contemplated, it must have input of geologists, soil mechanics engineers, hydrologists, and soil scientists. Preferably these disciplines should be representatives from agencies making this interpretation in order to obtain a blending of their experiences and expertise.

In addition, if such a rating system is established, several assumptions must be made and stated, as applicable, in the manuscript text for survey areas in which this interpretation is made. This will remove much discussion and debate about what is meant and intended when this rating is made. It is especially true in b. and c. because construction activities can create an unstable slope condition in soils that might otherwise be considered stable.

a. Soil mass wasting pertains only to near surface shallow mass wasting events and does not pertain to deep-seeted rotational slides that are related to the competence of underlying geologic materials, nor a result of earthquake activity.

b. Soil mass wasting interpretations be made for natural soil landscapes that have not been modified by man's construction activities.

c. Soil mass wasting interpretations do not pertain to geologically preloaded materials whose stress forces are confined within the natural landscape, but can be released by man's construction activities.

d. Soil mass wasting interpretations do not pertain to events caused by winter weather caused events such as snow avalanches or snow slides..

e. Soil mass wasting interpretations does not pertain to very shallow mud flow events that are related to frost action. These events are caused by saturation of the soil material immediately above ice and influence only the surface few inches

The committee recommends soil mass wasting interpretations be based on field observations of past slope failures and related to named kinds of soils. These observations must be discussed in map unit descriptions. They can also be identified on soil maps by spot symbols.

2. As the committee has recommended we make soil mass wasting ratings based upon observations of past events, it was deemed unnecessary to develop rating criteria based on soil properties. If, however, soil mass wasting potentials are developed in the future, there are sufficient soil properties discussed in the prior materials to form a nucleus of soil properties to start developing this interpretation rating.

Charge 3

1. The Washington Office has prepared a draft of Parts I and II, Section 404 of the National Soils handbook, Guide for Preparing Soil Potential Ratings. This has effectively responded to the initial portion of this committee's charge.

   Comments received pertinent to this draft have been received and are being incorporated into the document. Target date for finishing the policy and procedures is February, 1978.

   The committee recommends each State consider preparing soil potential ratings within the next two years for cropland, rangeland, or woodland uses in one survey area-containing broadly defined map units to test the procedures and evaluate the interpretations. The State should use the Guide for Preparing Soil Potential, Parts I and II, Section 404 of the National Soils Handbook to be issued in the near future. A brief resume of the State's findings should be forwarded to the Principal Soil Carrelator's Office for information and further action.

2. Attached (Appendix 1) is a list of soil characteristics, criteria and ratings to determine soil potentials for irrigated crop and tree production in New Mexico. The committee is offering this attachment as an example of how soil potential

criteria and ratings might be determined. It must be noted that unlike the draft guide's suggestion, the criteria is based upon a universe of the state rather than a local universe. This, however, does not detract from its usefulness as an example. Also attached is Appendix 2.

Charge 4

Again the committee must reiterate the need of a soil survey area work plan that adequately treats the intent and objectives of the soil survey. It should also identify the interpretations that are needed to meet the stated objectives. With the objectives in mind, the order of sail survey and components of map units can be established. If for some reason additional detailed soils information is required for a specific use not covered by the original soil survey work plan, it can be obtained by supplemental soil mapping at a higher order designed to treat these needs.

It must be recognized that various users of soil survey data may have different needs. Some may require detailed information, while others may only require general information. The primary thing that must be considered when developing soil interpretations is that they be more specific than the degree of map unit refinement and the displayed mapping detail. This has been a problem in the past. We have set up map units, whose components are at the Great Group, Subgroup. or Family level. but the interpretations are based upon a single pedon with or without defined ranges of characteristics. This is compounded by making interpretations that are more precise than the degree of mapping rather than general planning interpretations. This is wrong!

Committee No. 7 of the 1975 National Soil Survey Technical Work-Planning Conference recommended appropriate uses for the different orders of soil surveys. The committee feels it is appropriate to restate these uses because they are pertinent to this discussion and should be considered.

1st Order Soil Surveys. Very intensive planning for purposes that require appraisal of the soil resources of small areas. The map units are highly refined and for example provide accurate soils data for such uses as showing the soils of experiment plots and predicting sites for individual homes.

2nd Order Soil Surveys. Operations planning for purposes that require appraisal of soil resources for making predictions of the suitabilities of soils for use, their needs for management or treatment in a given use. Planning will involve predicting specific uses and treatment of discrete tracts of land but not site selection for structures.

3rd Order Soil Surveys. Applicable for general planning of county or multicounty planning districts and planning areas of extensive uses such as some extensive rangelands and arid lands. Not designed for interpretation for tracts of management size in intensive use.

4th Order Soil Surveys. Broad planning applicable to multicounty planning, large RC&D and RCOG, statewise planning and large state planning districts.

5th Order Soil Surveys. Very broad planning applicable to predicting major land uses in regional and state planning.

It is obvious from the definitions of 1st and 2nd order soil that examples of soil survey interpretations need not be mentioned in this discussion.

The design of map units, whether phases of soil series or soil families, in 3rd order soil surveys will predicate the types of interpretations that can be made. Interpretations made in map unit descriptions should conform to the above definition.

Soil interpretations that might be considered are those concerning potential irrigated cropland; rangeland uses including range site determinations, range seeding, methods of seeding, etc.; woodland uses including time site indices, harvest methods, etc.; general planning for road location and construction;

general planning for water management practices; resource materials; wildlife habitat suitability. Specific planning for road construction, irrigated cropland, and water management practices will require more detailed soil surveys and specific onsite detailed investigations.

Tabular displays of interpretation data for those survey area legends containing phases of soil series can be computer generated utilizing SCS-Soils-5 form data. A full array of all possible tables and columns may or may not be needed, or required. Thought should be given to selecting only those tables and columns needed to fulfill the objectives of the soil survey through its useful life. In those soil survey areas that have only a remote possibility of urbanization thought should be given to the use of combined tables utilizing only that data that is applicable to meet the objectives of the survey. Adoption of the proposed SCS-Soils-5A form will also provide additional tabular display possibilities.

At the present time, tabular. displays of interpretation data for those survey area legends containing phases of families must be 'hand' constructed. Interpretative data for soil families used to be recorded for computer tabular recall. This practice has been stopped for one reason or another.

Family criteria has a strong engineering bias. As such, it lends itself to selected engineering interpretations. Depending upon the phases recognized, it is conceivable that, within the criteria limits of the family, meaningful tabular engineering interpretations can be presented in much the same manner as those for phases of soil series. Some engineering interpretations are beyond the scope of map units consisting of soil families. These should not be made.

Present plans call for a review of interpretations of all members of selected families. This review will serve several purposes: (1) To determine the adequacy of Taxonomy criteria at family and higher categorical levels. (2) To test the classification of all of the family members. (3) To test and determine possible family phase criteria that might be utilized to obtain uniform interpretations at the family level (at least within major land resource areas). If these can be determined with a relatively high degree of consistency, it is entirely possible these interpretations may once again be placed in computer storage.

The committee recommends a review of stored SCS-Soils-5 data of all members of selected families to determine whether or not valid selected interpretations can be made for phases of families.

The design of mapping units in order 4 and 5 soil surveys, depending upon the components, necessitates only broad land use planning interpretations. A possible exception might be where phases of families are used in order 4 soil surveys. This will depend upon field procedures utilized in completing the survey, but is essentially similar to the prior discussion.

Some of the interpretations that might be made include rangeland uses whether utilized by cattle and sheep, reindeer or caribou, deer, etc.; potential cropland, whether dryland or irrigated; woodland, whether commercial or noncommercial; wildlife habitat; and watershed management.

Development of specific guidelines for making soil survey interpretations for phases of subgroups, great group, suborders or orders would, of necessity, depend upon the nature of the area being surveyed. A paint must be made at this time. There are very few interpretations that can be made at the order level. These increase in number with each successive taxonomic level because of the finite soil properties used to differentiate each. Regardless of the level of abstraction, the same interpretations must be made for all soils with the same classification unless specifically modified by phasing.

All tabular displays for these surveys, of necessity, must be "hand" constructed.

It is the committee's recommendation the work of this committee be continued.

APPENDIX 1

FEATURES OR CHAFWTERISTICS. CRITERIA, AND RATINGS TO DETERMINE THE SOIL POTENTIALS FOR THE PRODUCTION OF IRRIGATED CROPS AND TREES IN NEW MEXICO

(1 = least favorable; 5 = mod. favorable; 10 = most favorable)

Features or Characteristics	Criteria		Ratings
Basic Characteristics:			
Soil depth	deep	40+"	10
	mod. deep	20 - 40"	7
	shallow	10 - 20"	3
Surface texture	coarse		6
	mod. coarse		10
	medium		10
	mod. fine		10
	fine		6
	coarse frag.	>15%	6
Permeability	very slow	<.06	2
	slow	0.06 - 0.20	6
	mod. slow	0.20 - 0.60	8
	mod.	0.60 - 2.00	10
	mod. rapid	2.00 - 6.00	8
	rapid	6.00 - 20.0	6
	very rapid	>20.0	2
Total available water capacity in rooting depth	high	>7.5	10
	medium	5.00 - 7.5	C
	low	3.75 - 5.0	5
	very low	<3.75	1
Soil temperature		<47°F	4
		47 - 59°F	8
		59 - 72°F	10
Growing seasons (days)		>180	10
		140 - 180	8
		<140	4
Depth to water table		<10"	1
		10 - 20"	4
		20 - 40"	8
		>40"	10
Organic carbon	high	>2.5%	10
	medium	0.6 - 2.5%	8
	low	<0.6%	6
Calcium carbonate equivalent within rooting depth		>40%	4
		15 - 40%	8
		<15%	10
pH		>9.1	1
		8.5 - 9.0	4
		7.9 - 8.4	8
		6.1 - 7.8	10
		5.1 - 6.0	6
		<5.1	2

Features or Characteristics	Criteria	Ratings
Basic Characteristics (Continued):		
Mineralogy	montmorillonitic	6
	mixed	10
	carbonatic	4
	gypsic	1
K factor (use when slopes are greater than 2%)	<.20	10
	.20 - .37	8
	<.37	6
Map Unit Features:		
Slope	0 - 1%	10
	1 - 3%	8
	3 - 5%	6
	5 - 9%	4
	>9%	1
Erosion hazard	slight to moderate	10
	high	5
	very high	1
Flooding	none or rare	10
	occasional	7
	frequent	1
Stoniness/rockiness	none	10
	stony/rocky	5
	very stony/very rocky	3
	extremely stony/extremely rocky	1
Salinity	<4 mmho	10
	4 - 8	8
	8 - 15	4
	>15	1
Wind erodibility group	>5	10
	3, 4, 4L	7
	1. 2	3

APPENDIX 2

Guides for preparing soil potential ratings for crops and non-crop interpretations have been proposed by the SCS (Soil Survey Manual, draft; Advisory Soils-13, 1977). These guides suggest some input of management to obtain semi-quantitative ratings, and such numerical ratings of soils are beneficial to the soil user and the land use planners.

Inherent in such calculation of numerical ratings is a list of criteria which are necessary to rate a particlar soil for a specific use. These criteria have been proposed for the Histosols (South Technical Service Center) and for maize (Nichols, 1975; Bartelli et al., 1974). These studies should be reviewed.

Search of the literature far various crops, especially those of the tropics, does not give adequate information. The lack of precise published information may be due to the diversity of the soils, different varieties of a crap, and differences in climatological requirements.

The list of criteria could, therefore, be prepared in such a way that the above information be compiled by referring to pertinent research results or by consulting the specialists who are thoroughly familiar with a crop or a specific use. The organization of a table of the criteria could then be a major contribution of this committee.

The semi-quantitiative ratings could. furthermore, become more useful if they could show the degree of performance, for example, "X" kg per ha per year with a given amount of input.

Discussion - Charge 1

Chugg

Charge 2

(FOR DISCUSSION ONLY)

SOIL INTERPRETATIONS RECORD

ESTIMATED SOIL PROPERTIES

ROADS

ROAD BASE MATERIAL

SHALLOW EXCAVATIONS

RECREATIONAL DEVELOPMENT

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

WOODLAND SUITABILITY

MANAGEMENT PROBLEMS

WINDBREAKS

WILDLIFE HABITAT SUITABILITY

POTENTIAL FOR HABITAT ELEMENTS

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

FAVORABLE YEARS

UNFAVORABLE YEARS

FOOTNOTES

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Soils and Soil Materials Disturbed by Mining Operations
Committee 5
San Diego, February 13-17, 1978

Committee Members: G. Nielsen (Chrmn.), J. Rogers, D. Robertson, J. Chugg, L. Daugherty, D. Nettleton, R. Piper, T. Hutchings, D. Jones, R. Richlen

Charge 1.

Assemble the available guidelines prepared by the different cooperators in the NCSS for reclamation of mine spoils. Assemble a summary of available guidelines in a form that can be used as a guide for developing general standards for all cooperators. 1/

INTRODUCTION

This charge was continued from the 1976 meeting (19). The 1976 committee used research results from Colorado, New Mexico, Utah, North Dakota, and Montana to define many of [redacted] guidelines for evaluating the suitability of soil material for use as cover-soil 2/ on spoils. Little coordination has existed between these groups. The goal of this committee has been to collect available guidelines and synthesize a set of summary guidelines usable by all cooperators and interested parties outside the NCSS.

DISCUSSION

Need for Guidelines

Guidelines for evaluating the suitability of soil material for use as final cover on mine spoils plays a critical role in reclamation of mined land (Fig. 1). Most states require pre-mining studies of soils, geologic overburden, vegetation, and other features to evaluate the impact of mining. A reclamation plan is normally required which includes plans for replacement of cover-soil on regraded spoils. In North Dakota, 30 inches of topsoil are required over sodic spoil to insure maximum benefits (1). Guidelines are useful in locating the areal extent and maximum depths of the best available cover-soil material on soil inventory maps.

Guidelines which rate the suitability of soil materials for use as cover-soil may not be adequate to insure that the best available material in a mine area is replaced at the spoil surface. Strip mine operations disturb far more than the top 2 to 3 meters that constitute soil material. Guidelines may also be needed to evaluate the suitability of non-soil overburden for use as cover-soil (17). Through placement of beneficial materials on the surface of spoils, it may be possible in some cases to improve soils through mining.

Summary of Available Guidelines

Numerous research reports have listed key properties for evaluating soil and overburden [redacted] Many quantitative guidelines have been developed for evaluating soil materials for use as cover-soil (2,3,7,12,14,15,20). Soils are usually rated good, fair, or poor based

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1/ Prepared by W. M. Schafer.

2/ Cover-soil is defined as soil material suitable as plant growth medium.

on several properties. Some guidelines also rate the availability of material based on factors such as slope and drainage. All available guidelines are shown in Table 2. Development of guidelines for each individual mine has also been suggested (3).

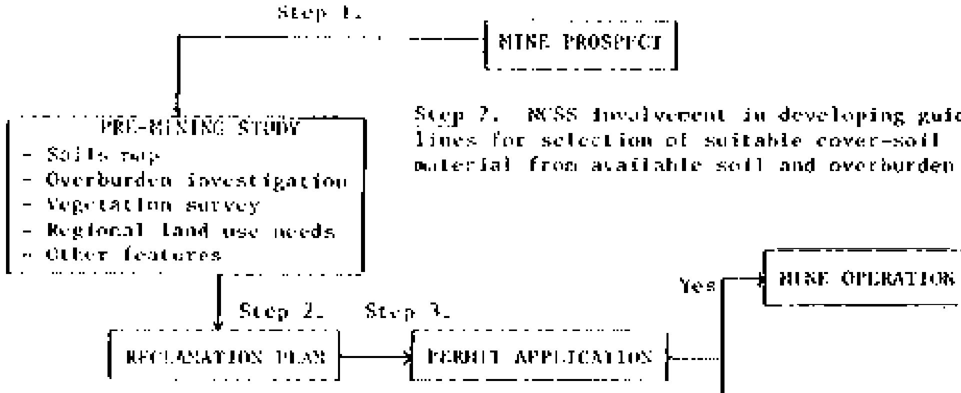

Fig. 1. How guidelines for selection of cover-soil fit into the mine planning framework.

Proposed Unified Guidelines

A single set of guidelines was formulated from all previously available guidelines shown in Table 2 with additional input from reports on reclamation research (1,17). When a majority of sources agreed on critical levels of key properties, they were included directly in the summary guidelines. If large discrepancies existed, conservative levels were chosen except in the case of coarse fragments. Some properties were not included if they were not widely used or were poorly defined; other properties were added if research findings warranted their inclusion. Many review comments from committee members and other workers in reclamation were incorporated into the unified guidelines. The format of the guidelines has been designed so soil materials and non-soil overburden can be evaluated (Table 3).

Limitations of Guidelines

Guidelines that use good, fair, and poor have many shortcomings. If all possible soils rate as poor, there is no way to select the best available material (4). In some cases, simple soil amendments or treatments could change a materials rating from poor to good. It is possible that better material for use as topsoil exists in the non-soil overburden than is available in soils before mining. Most guidelines currently available are not aimed at rating overburden suitability. Use of the soil potential index developed by the SCS may be applied to rating the reclamation potential of minesoils. For example:

Soil potential index (SPI) = P - Ct - Cl

P = Index of performance or yield of regionally important soils before mining.

Ct = Index of relative treatment costs to overcome limitations. These may include gypsum application, supplemental irrigation or fertilization, or erosion control.

Cl = Index of relative costs of continuing limitations. These may include maintenance fertilization or irrigation; reseeding; low forage yield; or excessive erosion.

Application of Guidelines

Soil maps of prospective mine areas are used in conjunction with guidelines to select cover-soil material. The ability to obtain the best available material depends not only on guidelines but also on the quality and detail of soil maps. Many suggest that order 2 or order 3 maps may be used with or without special modifications (2,3,20).

However, some states require mapping more detailed than order 1 (6). Recommendations about suitable mapping intensity should probably accompany guidelines. Order 2 or 3 soil surveys are useful for general planning but must be supplemented by order 1 maps or on-site investigation for purposes of cover-soil collection.

Minesoils are variable, and unlike undisturbed soils, their variability is not related to land forms or slope position. Procedures for mapping minesoils and for developing interpretations for mined land are needed. Interpretations should include consideration of any properties unique to minesoils. Minesoils often contain a large volume of rock fragments, stratifications of contrasting texture, and may have potentially toxic levels of some trace elements.

Recommendation

The committee accepts the guidelines in Table 3 and accompanying report in fulfillment of Charge 1.

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Table 2. List of properties used to evaluate cover-soil, overburden, and minesoil potential.

Cover-soil selection 1/	Overburden suitability 2/	Minesoil characterization 3/
Texture class (1,2,3,6,9,11,12, 14.21) 4/	pH (1,2,3,6,10,17)	pH (5,13,15,16,18)
EC (1,2,6,9,11,12,14,21)	Texture (1,2,6,10,21)	Texture (5,13,16,18)
ESP (2,3,9,14)	E C (1,2,3,6,10,21)	Slope (5,13,15,18)
Stoniness class (3.12.14)	SAR (1,2,3,6,10,21)	Erodibility (5.18)
Slope (2,3,9,12)	Acid-base account (17)	Stoniness (5,13,15,18)
Coarse fragments (2,12,14,21)	Extractable K, Ca, Mg, P (17)	Coarse fragments (16,18)
Thickness (2,3,9,12)	Bicarbonate-P (17)	Fragment rock type (5,16,18)
pH (1,2,6,9,11,21)	Material type (1.17)	Base saturation (18)
Moist consistence (12,14)	Rock slaking (17)	Organic matter (18)
Drainage (3.12)	Lime requirement (17)	Rock hardness (180
SAR (1,2,6,21)	Total elemental Al, Fe. Mn, CU. Zn, Cd, Ni. Ch. Pb (17)	Fragment size (18)
Water-holding capacity (1,2,3)	Avail. Fe, Cu, Mn, Zn, Cd, Ni, Pb, Hg, Se, Mo, B, NO_3, NH_4 (6)	Toxic trace elements (18)
Inherent fertility (14)	ESP (1.6)	Shrink-swell (18)
Lime content (1,9,11,21)	Saturation % (1,6,21)	Drainage (18)
Hydraulic conductivity (1,3,11)	NO_3^- (21.6)	Fertility (18)
Erodibility (3)	$SO_4^=$ (21)	Available water
Weatherability (3)	$CaCO_3$ % (1,10)	EC (18)
Saturation % (1,6,21)	Available water (1)	Permeability (18)
B (6)	Hydraulic conductivity (1,3)	Land use (5)
Organic matter (1,9,11)	Clay mineralogy (1)	Depth (5)
Se		Aggregation (5)
Clay mineralogy (1.11)		vegetation (5)
Aggregation (9)		Color, mottling (16)
		Fabric (16)
		Temperature (16)
		SAR (6)
		Saturation water % (6)
		$CaSO_4$ (6)
		N, P. K (6,21)

1/ Data from research and guidelines for selecting soil material for use as cover-soil.
2/ Important properties for evaluating overburden use as cover-soil.
3/ Properties important for minesoil classification, interpretation, and characterization
4/ Numbers refer to literature cited at the end of this report.

Table 1. Summary of available guidelines for rating soil material for use as cover-soil in strip-mine reclamation.

	Factors Affecting Use	SCS—ND (14) Good	SCS—ND (14) Fair	SCS—ND (14) Poor	SCS—Eng. Tec. Guide (12) Good	SCS—Eng. Tec. Guide (12) Fair	SCS—Eng. Tec. Guide (12) Poor	BLM-EMRIA (2) Good	BLM-EMRIA (2) Fair	BLM-EMRIA (2) Poor	MDSL (7) Suspect level	[illegible] (20) Good	[illegible] (20) Fair	[illegible] (20) Poor	Unchangeable c/
Factors affecting suitability of materials	Texture	fsl,vfsl,l, sil,si	cl,scl, sicl	s,lfs,ls, c,sic	fsl,vfsl,l, sil,si;sc if 1:1 clay is dom.	cl,scl,sicl; sc if 2:1 clay is dom. c & sic if 1:1 clay dom.	s,ls,c; sic if 2:1 clay	sl,fsl,vfsl, l,sil,si, cl, scl,sicl	sc,sic, c	s,ls	s,ls,sc, c,sic	sl,l,sil, scl	cl,sicl, sc,ls	c,sic,s	--
	Moist consistence	vfr, fr	lo,fi	vfi,exfi	vfr,fr	lo,fi	vfi,exfi	--	--	--	--	fr	lo,fi	vfi	--
	Dry consistence	--	--	--	--	--	--	--	--	--	--	lo,sh	sh,h	vh	—
	Coarse fragments (% vol.)	<3	3-15	>15	0-3	3-15	>15	<15	15-35	>35	--	--	--	--	--
	EC (mmhos/cm-satn. extr.)	<4	4-8	>8	<4	4-8	>8	<8	8-16	>16	[illegible]	<4	4-8	8-16	>16
	ESP (%)	not determining if less than 15%		>15	--	--	--	<2 a/	2-15	>15	--	--	—	--	—
	SAR (satn. extr.)	--	--	--	--	--	--	<7	7-12	>12	10 b/	<6	6-10	10-15	>15
	pH	--	—	--	--	—	--	5-8.5	3.5-5.0	<3.5;>8.5	8.8-9.0	6.0-8.4	5.5-6.0 8.4-8.8	5.0-5.5 8.8-9.0	<5.0 >9.0
	Stoniness class	0	1	2-5	0	1	2-5	--	--	--	--	--	—	--	--
	Lime content	low	med.	high	--	—	--	--	—	--	--	none-sl (0-15%)	mod. (15-30)	high (>30)	
	Boron (ppm)	--	--	—	--	--	--	--	--	--	8		5	>5	
	Se (ppm)	--	--	--	--	—	--	--	--	--	--		2	>2	
	Inherent fert.	high & medium	med.	low	--	--	--	--	--	--	--	--	--	--	--
	Saturation percentage	--	--	--	--	--	--	--	--	--	--	25	80	>80;<25	--
	Available water capacity (inches/inch)	--	--	--	--	—	--	>.1	.05-.1	<.05	--	—	--	—	—
Factors affecting avail. of materials	Slope (%)	--	—	—	<8	8-15	>15	<8	8-15	>15	--	—	—	--	—
	Depth of material (inches)	--	--	—	>16	8-16	<8	>40	20-40	<20	--	--	--	--	--
	Drainage class	--	--	--	drainage class not determining if better than poorly drained		poorly, very poorly drained	--	--	--	--	--	--	--	--

a/ Rate 2:1 clay texture poor if ESP > 10; sand texture poor if ESP > 20.
b/ Sandy textures permit higher level.
c/ Establishment of vegetation on soils having any of these extreme conditions would be severely restricted.

Table 3. Proposed unified guidelines for rating the suitability and availability of material for use as [illegible]

	Factor affecting use a/	Good	Fair b/	Poor c/	Ref. d/	Methods
Factors affecting suitability of soil material	Texture class	vfsl,fsl,sl,l,sil	[illegible]	[illegible]	17,14	ASA. Agron. Mono 9. Methods of Soil Analysis. 31. 15-4. pp. 1062-1063.
	Moist consistence	vfr,fr	lo,fi	vfi,exfi	12,14,20	Soil Survey Manual. p. 233.
	EC (mmhos/cm)	<4	4-8	>8	12,14,20	USDA Hndbk. 60. pp. 88-89.
	ESP	<15		>15	2	Soil Survey Investigations. Rpt. 1. p. 21. Method 5D1.
	pH	6.0-8.4	5.0-6.0; 8.4-8.9	<5.0; >8.9	2,7,20	Soil Survey Investigations. Rpt. 1. p. 59. Method 8C1a. Use indicator dyes for field estimate.
	Stoniness class	0	1	2-5	12,14	Soil Survey Manual. pp. 217-219.
	Available water capacity (% by volume)	10	5-10	<5	2	Soil Survey Investigations. Rpt. 1. p. 14. Method 4C1.
	Rock fragments (%)	<15	15-35	>35	7	Estimate
	Saturation water (%)	25 - 80		<25; >80	20	USDA Hndbk. 60. p. 84. Method 2.3a.
Factors affecting avail. of soil materials e/	Slope (%)	<8	8-15	>15	2,12	Measurement
	Depth (in.)	>40	20-40	<20	2	Measurement
	Drainage class	not class determining if better than poorly drained		poorly to very poorly drained	12	Soil Survey Manual. pp. 169-172.
Additional factors affecting suitability of overburden	Material or rock type	weakly consolidated sandstones & siltstones, & unconsolidated surface deposits (i.e., loess; till; recent alluvium; and colluvium)		Indurated sandstone & siltstone, shale, clayey or gravelly material	1,11	Observation
	Water slaking f/	1 - 10		0-1	18	See ref. 18.
	Trace elements g/ i/	less than limits at right		ppm B > 8 Cd > 0.1-1.0 Cu > 40 Fe h/ Pb > 10-20 Mn > 60 Hg > 0.4-0.5 Mo > 0.3 Ni > 1.0 Se > 2.0 Zn > 40.0 NH_4-N i/ NO_3-N i/	7	See ref. 7.

a/ Factors at the ... of the table are used t... te the suitability of soil materials. F...
middle. Suitab... ty of non-soil overburde... n be evaluated using underlined factors...
b/ Mitigation of a... se properties will incr... reclamation potential.
c/ Materials rated ... poor may be suitable as ... soil only if adverse factor can be treat...
d/ Numbers relate ... literature citations at ... end of this report.
e/ Limits from thi... ection can be waived if ... mine company is able to collect material ... nd these lim... hou...
f/ Other tests may ... suitable. At least 30% ... material should weather into <2 mm parti... ithin 1 year ... su... cm.
the slaking tes... ndicates that 0-10% of a... gment has passed a 5 mm sieve after 10 &... submerged i...
g/ Selected trace ... ments should be analyzed ... n this list if they are a demonstrated r... l problem or ... uir... te
h/ Analyzed becaus... f antagonism with other ... ients. High Fe may mitigate high levels ... her metals. ... efi... uld
i/ High nitrate le... s can cause groundwater ... ution. The federal drinking water stand... 10 ppm NO_3^-.
j/ Many of the qua... tative limits shown belo... e not well documented with actual ... dings. Some ... reg... may

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Charge 2.

Develop criteria for Fluvents and Fluventic subgroups that would exclude soils from mine spoils that have irregular distribution of organic matter. 3/

The following is proposed as a method for keeping mine restored areas out of the Fluvents suborder and Fluventic great groups and subgroups.

Suborder - Fluvents: Other Entisols that do not have a lithic or paralithic contact within 25 cm of the soil surface and that have slopes of <25 percent and organic carbon content that decreases irregularly with depth in strata parallel to the soil surface or remains above a level of 0.2 percent to a depth of 1.25 m, and the mean annual soil temperature is higher than 0°C. (Strata of sand or loamy sand may have less organic carbon if finer sediments at a depth of 1.25 m or below have 0.2 percent organic carbon or more.)

Great Group - Fluvaquents: Other Aquents that have an organic carbon content that decreases irregularly with depth in strata parallel to the soil surface or that remains above 0.2 percent to a depth of 1.25 m; and that have texture finer than loamy fine sand in some or all subhorizons between the Ap horizon or a depth of 25 cm, whichever is shallower. Thin strata of sand may have less organic carbon if the finer sediments at a depth of 1.25 m or below have 0.2 percent organic carbon or more.

Subgroup - Fluventic or Fluvaquentic: Have a regular decrease in organic carbon content with increasing depth in strata parallel to the soil surface to a level of 0.3 percent organic carbon or less within 1.25 m of the soil surface, or the slope is >25 percent.

Recommendation

Change the definitions of Fluvents and Fluventic subgroups to exclude soils from mine spoils. This is accomplished by adding the phrase "in strata parallel to the soil surface" to statements indicating that O.C. decreases irregularly with depth. Examples are provided.

3/ Prepared by L. N. Langan.

Charge 3.

Wind erosion is very difficult to manage on mill tailings. Assemble research data on the management of mill tailings. Develop criteria for classifying mill tailings and assemble best management practices for erosion control. 4/

Minimizing wind erosion on mill spoils on a long-time basis could perhaps best be accomplished by either establishing a vegetative cover or adding a thin rock cover. Where vegetation cannot be established in arid areas there may be opportunities to duplicate the desert pavement which is an effective barrier against wind erosion. A review of 10 soil descriptions has shown that the pavements cover about 65 to 90 percent of the soil surface. These pavements are only about one rock layer thick. An average thickness is about (2 cm) 0.8 inch.

Tons of rock required to protect the mill spoil from wind erosion:

Coverage %	Weight of Coarse Fragments T/A
50	60
60	70
70	85
80	95
90	110

Commonly a second problem exists in mill spoils--the soil pH is too low for plants to grow. Soil pH in acid spoils commonly are in the range between 1.5 and 3.5. The problem can be corrected by incorporating lime. The rates required will be determined by the acidifying potential of the pyrites present in the mill tailings. For example, assuming a pH of 4.5 as a minimum practical pH for plant growth, Priest, et al. (1977) reported initial lime requirements as follows:

Soil pH (1:1)	Lime T/A - 6 inches
1.0	100
1.5	30
2.0	10
2.5	3
3.5	1

Continued oxidation of the pyrite may require additional application of lime.

Depending on the nature of the spoil a combination of rock and lime may be a good treatment. The rock would protect the site from wind erosion and increase penetration of the precipitation in dry areas; the lime would help protect the surface and also neutralize the acidity. If limestone is available in quantity, it could be used as the rock source. It should not be crushed below gravel size so that it can protect the spoil surface against wind erosion.

The report for Charge 3 presents some ideas that may be helpful in managing pyrite-rich tailings and other toxic tailings in arid regions. However, these suggestions do not apply to tailings still in use. Several specific issues remain unanswered. How would rock cover influence the moisture regime of the tailings pile? Would application of wood chips, sewage sludge, or cover-soil be practical on some tailing piles?

Recommendation

A comprehensive search for research data on management of mill tailings has not yet been accomplished nor have criteria been developed for classifying mill tailings. No specific recommendations are made except that this report be forwarded to future committees that may pursue solutions to these problems.

4/ Prepared by A. J. Erickson. T. B. Hutchings, and W. D. Nettleton

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WESTERN REGIONAL TECHNICAL WORK-PLANNING
CONFERENCE OF THE COOPERATIVE SOIL SURVEY

Techniques for Measuring Source and Yield of Sediment
Committee 6

The following

Charge No. 1: The modified western guides for application of the nomograph and USLE are being used. Values for K, considered best estimates, are being determined from laboratory data and field descriptions of the series.

The nomograph-determined K factor is an average for the soil material considered. The procedure is designed to use an average silt plus very fine sand to remaining-sand ratio for the texture without regard to ranges, or distribution patterns within classes of particle sizes, coarse fragments, organic matter, or structures. Utah has developed and presently employs a set of K factor guides that depend on ranges of the classes of the properties used. (Erickson, A. J. 1973. "Aids for Estimating Soil Erodibility - "K" Value Class and Soil Loss Tolerance.") These ideas have been incorporated in other state manuals.

In California, rainfall simulator studies have shown a strong relationship between relative erodibility and exchangeable sodium percentage or free iron in certain soils. These properties are not now used in the Wischmeier nomograph approach. They have not been tested as yet for statistical significance against other properties, but may become important when additional field measured K values for such soils are obtained.

It has been noted that erodibility of a given soil changes significantly as a result of compaction, as can happen at construction sites. Should this be treated as an alteration of the K factor, or as a management (C) factor? Concern has also been voiced about the use on forest land of a system (USLE) that was originally developed from data gathered from cultivated soils. The western modifications, previously mentioned, took this into account, particularly in the C factor valuation. However, this, as well as other regional concerns, cannot be wholly satisfied until more base-line erosion data is obtained.

Charge No. 2: The C factor is probably the most complex, as well as flexible factor, in USLE. It is subject to manipulation and allows a wide range of the use of USLE as a tool or aid in solving conservation problems. It has been termed a cropping-management factor. With modification of USLE for use on undisturbed land areas it has become the vegetation-management factor. Properly used, it estimates the long time probable average effect of its components in reducing soil loss and integrates seasonal plant growth-rainfall interactions. Logical values have been developed for its Type I, II, and III elements from comparable elements for agricultural crops and rotations. For many combinations of cover and management, computed values from the theory for a natural cover factor approximate those figures obtained from years of field studies undertaken to develop values for crop and crop stage effects in reducing erosion. However, the complexity of the factor creates many combinations that need supportive field data to verify, or possibly adjust, in order to bring USLE predictions closer to reality in the west.

Conclusions and Comments: The soil loss equation (USLE) represents the best systematic approach yet devised to explain and predict (within still very circumscribed limits) the complex phenomenon of sheet and rill soil erosion by rainfall. The term "universal" is misleading to some, and at this stage may be premature. However, the system, the concepts involved, and their statistical foundations do point to a more effective, comprehensive means of studying and managing erosion provided much additional research data is obtained.

With prudence and good judgement, the USLE modified for western conditions is a useful tool. It can be misused if not thoroughly understood.

In the past there have been very few formal erosion studies in the west using standard plots. Besides the Palouse Conservation Field Station in Washington, there are standard erosion plots currently functioning in California (42), Idaho, and Utah (2). Unfortunately, in the latter three states the short term existence of the plots and the recent drought years have minimized useful data collection. Sites with several plots are planned for Montana, Colorado, and New Mexico. All of these, in time, can provide some additional basic information about the K factors of specific soils, as well as some C factor information. It is the consensus of the Committee that much more is needed, regionally, to verify these factor values for the modified USLE, many of which have been projected by computation beyond recorded observations. This also applies to the LS and R factors.

[redacted]

Assuming an input from normal Experiment Station research facilities and leadership, plus agency cooperation (site location and maintenance), at present-day prices and salaries it is estimated that a set of six standard erosion plots with full sediment traps, modestly but suitably designed, installed and instrumented to record rainfall intensity and quantity and managed for a year, would cost about $32,000 including travel and institutional overhead. Each additional set of six plots, up to six sets, added the same year would cost about $6,300, including monitoring, data collection and processing. With seven sites (42 plots), a subsequent six-year data collection period would average about $43,000 per year, including salaries, overhead, travel, laboratory, maintenance costs and an inflation factor. Such a program in the 13 states could produce a maximum of 3822 plot years of data!

Recommendations:

1. Continue use of USLE in the western region with care, caution, and good judgement.

2. Encourage establishement of additional erosion studies throughout the region with emphasis on standard studies on benchmark soils. Within the states, foster cooperative field studies between Experiment Stations, USFS, SCS, BLM, ARS and other appropriate and interested federal or state agencies.

3. The Committee be continued to evaluate and report on data to be obtained from existing erosion plots in the western region.

4. The Committee be augmented with specialists in sediment yield to explore with soil-loss specialists and to comment on the interface between source and yield of sediment.

The report of the Committee was approved and accepted by the conference membership.

Committee Members:

A. Erickson	E. Naphan
A. Ford	K. Nelson
M. Fosberg	A. Southard
O. Harju	R. Tew
A. Leven	G. Huntington, Chairman

CALIFORNIA AGRICULTURAL EXPERIMENT STATION ACTIVITIES
IN THE
NATIONAL COOPERATIVE SOIL SURVEY

G. L. Huntington [1/]

The California Agricultural Experiment Station (CAES) is currently active in the cooperative soil survey program in the following ways:

1. Reviews and assists in the classification and correlation of new and revised soil series from active survey areas under the Soil Conservation Service, U.S. Forest Service, and the State Soil-Vegetation Survey Project.

2. Participates in field reviews of active soil survey areas.

3. Participates in development of new soil survey area work plans or amendments thereto.

4. Pursues special field studies addressed to the solution of current classification or mapping problems.

5. Provides laboratory studies of typifying pedons sampled for the Soil-Vegetation Survey Program in the state (Calif. Dept. of Forestry - Pac. SW For. & Range Exp. Sta., USDA).

6. Assists in manuscript preparation and agricultural soil ratings.

7. Participates in presentation programs for new county or area soil survey reports.

8. Acts as a partner with the SCS and/or USFS in Work-learn or Internship programs for student trainees in soil science and resource conservation; provides special or refresher field training for SCS personnel; participates in soil scientist training and soil classification workshops at state or regional levels; sponsors, in coordination with the Cooperative Extension Service and SCS, state regional workshops in the use of soil survey information for consulting and public planners.

9. Through the Dept. of Land, Air and Water Resources, Davis, and the county Farm Advisor offices, acts as a distributor of soil survey reports to the public.

10. Fosters and participates in the inter-agency working forum known as the California Soil Survey Committee.

The CAES no longer has a regular staff of field soil scientists assigned to or leading active soil survey areas in the state. This work in California has now been entirely assumed by staff from the SCS, USFS, and PSWF&RES.

Since formally reporting to this Conference in 1974, an inter-agency organization has been fully developed within California which addresses itself to local needs and concerns of the Cooperative Soil Survey. It is organized to be, in part, a state level extension of this Conference and to act as an organized means for upward communication of state level ideas.

For many years the CAES has annually sponsored the California Soil Survey and Land Classification Work Planning Conference. This is an annual forum, for all state and federal agencies and individuals active or interested in the Cooperative Soil Survey, at which there is discussion of current progress and of future plans and needs of the Survey. The California Soil Survey Committee was a "spin-off" from the annual Conference in 1974. The Committee consists of "principal members" from the active agencies in soil survey, and "associate members" from these and other agencies selected to work on subcommittees having specific charges directed toward current survey problems. The Committee now meets four times a year to review and discuss subcommittee reports and offer guidance for further work. Its winter meeting is held in conjunction with the annual Conference.

Excellent inter-agency rapport has been developed and significant progress made toward the resolution of some problems that may exceed the normal scope of a single agency. For example: sponsoring and coordinating a "soil temperature day" to improve the state soil temperature regime map; developing and field testing proposed modifications of definitions for lithic-paralithic contacts and materials in conjunction with a study of the definitions' effects on recognition of fragmental and skeletal particle-size classes. Currently, the CSSC is fostering an inter-agency approach toward preparation of a new general soil map of the state.

Attached is (1) an outline showing the place of California's annual Conference and its Soil Survey Committee in the communication network of the NCSS, and (2) the By-Laws of the Committee.

1/ Experiment Station Representative - National Cooperative Soil Survey. Dept. of Land, Air & Water Resources, University of California, Davis.

THE NATIONAL COOPERATIVE SOIL SURVEY

A California View of its Communications Network

The National Cooperative Soil Survey is an operating program without formal organization or headquarters, yet it exists, functions and is recognized as the coordinating force between federal and state agencies (particularly Land Grant Colleges) that have for many years collaborated in the soil survey of the U.S. The following conferences and work groups exist and give life to the NCSS program in California:

Conferences or Working Groups	Meet
1. National Technical Work Planning Conference of the Cooperative Soil Survey (1)	Once every 2 years, odd numbered years
2. Regional Technical Work Planning Conferences of the Cooperative Soil Survey (4) Western Southern Northeastern North-Central	Once every 2 years, even numbered years
(Western Regional Coordinating Committee - 30, Land Grant Colleges)	Concurrently with W. Region. Conf.
3. California Soil Survey and Land Classification Work Planning Conference (1)	Once each year
4. California Soil Survey Committee (1)	Four times each year

[redacted]

f. Soil Climate
g. Education & Extension
h. Others as deemed needed by CSSC

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By-Laws

of the

California Soil Survey Committee

Article I. Name

The name of the organization shall be California Soil Survey Committee. The initials CSSC may be substituted where appropriate.

Article II. Purpose

The purpose of this organization shall be:

1. To provide a forum for discussion of soil survey problems or topics of common technical interest open to all agencies participating in the National Cooperative Soil Survey, USA.

2. To seek solutions to specific problems in soil survey through subcommittee work.

3. To review the work of the subcommittees at regular meetings of the organization.

4. To report annually the work of the organization and its subcommittees to the California Soil Survey and Land Classification Work Planning Conference.

5. To present proposed amendments to the current national systems of soil classification and land evaluation, and/or recommendations for studies in specific areas of soil classification or evaluation, to the above Conference for its consideration and transmittal to appropriate committees of the Regional or National Work Planning Conferences in soil survey.

Article III. Membership

Section 1. Two types of memberships are recognized for this organization. These are: 1) principal memberships, 2) associate memberships.

Section 2. Principal Members are defined by position in any federal, state, or other agencies involved in the soil survey of California.

Section 3. Principal Members may designate, as necessary, other personnel in their own agency as Associate Members for technical discussion or for subcommittee assignment.

Section 4. Upon adoption of these By-Laws, the following positions qualify the holder to Principal Membership:

State Soil Scientist, California, Soil Conservation Service, USDA

Chief, Soil and Geology Group, California Region, US Forest Service, USDA

Project Leader, Soil-Vegetation Survey, Pacific Southwest Forest and Range Experiment Station, USDA

Experiment Station Representative - National Cooperative Soil Survey, University of California

Section 5. Other agencies that become involved in the California soil survey may be invited to join the organization in the person of the agency's soil survey leader who assumes a Principal Membership.

Section 6. Other Agencies who have interest, but are not actively engaged in the California soil survey, may be invited to join the organization in the [redacted]

Article IV.

Section 1. The organization shall meet quarterly, preferably during the months of March, June, September and December. At each meeting a specific date will be set for the next succeeding meeting, except for the month of December when the organization meets with the California Soil Survey and Land Classification Work Planning Conference.

Section 2. A quorum for each regular or special meeting will exist by the presence at least of all Principal Members or alternate(s) designated by Principal Member(s).

Section 3. Subcommittees will meet as necessary to fulfill their charges.

Section 4. Special meetings of the organization may be called by the Chairman.

Article V. Officers, Duties, and Terms of Office.

Section 1. The officers of the organization shall be: Chairman, Vice-Chairman, and Secretary.

Section 2. The Chairman shall:

a. Perform the usual duties of the office, including issuance of meeting calls to the membership.
b. Preside over all meetings of the organization and of the Executive Subcommittee.

Section 3. The Vice-Chairman shall:

a. In the absence of the Chairman, or in case of his inability to act, exercise the duties of the Chairman.
b. Assist the Chairman in matters of agenda for meetings.

Section 4. The Secretary shall:

a. Keep the minutes of all regular and Executive Subcommittee meetings.
b. Provide copies of minutes of each regular meeting to all members.
c. Be the recording office of the organization and custodian of records, except those specifically assigned to others.

Section 5. The terms of offices shall be for one year beginning with the spring meeting.

Section 6. The selection of officers shall be from among the Principal Members, and shall be by a system of rotation of offices through all Principal Members in a manner to be determined by the Executive Subcommittee.

Article VI. Subcommittees

Section 1. The Executive Subcommittee will be a standing subcommittee in this organization. It shall consist of all Principal Members.

Section 2. The need for other subcommittees for specific problems in soil survey shall be determined by vote of members at any regular or special meeting. A list of charges shall be prepared and given to each subcommittee formed.

Section 3. Membership of all subcommittees shall be appointed by the Principal Members, who shall also designate the subcommittee chairman.

Section 4. The period of existence of a subcommittee shall be determined by it's charge or by vote at a regular or special meeting.

Article VII. Voting

All members of the organization, principal and associate, have one vote to be exercised on any and all orders of business, technical questions or recommendations brought before the organization, and on any or all amendments to these By-Laws.

Article VIII. Amendments to the By-Laws

These By-Laws may be amended by a two thirds majority vote at a regular meeting, providing the amendments were presented for discussion at the previous regular meeting. Content of the amendment, or amendments. must be made known to members absent from the discussion meeting.

Prepared and forwarded for approval by the By-Laws Subcommittee, CSSC, 10/18/74

By-Laws accepted by CSSC, 12/10/74

Amendments -

7/7/77 Article III, Section 4.

add Soil Scientist. State Office, Bureau of Land Management, USDI.

FIELD TRIP

WESTERN REGIONAL SOIL SURVEY WORK CONFERENCE

FEBRUARY 15, 1978

SAN DIEGO, CALIFORNIA

FIELD TRIP

Western Regional Technical Soil Survey Work Conference
February 15, 1978
San Diego, California

7:45am Start boarding bus

8:00am Leave motel.
Observe man-made soils along Mission Bay Drive.
Observe Harbor Scene on way to stop 1.

Stop 1 Classification Questionable
Lab data at 18 inches.

BS (NH_4OAc)	39.4 meq/100 gms.
Sodium	1.7 meq/100 gms.
Potassium	0.1 meq/100 gms.
CEC	41.8 meq/100 gms.
O.C.	0.61%

(data courtesy University of California, Davis)

This soil has 10YR3/2 colors throughout, and has a clay loam

mollic epipedon and clay argillic horizon. The argillic horizon has numerous cracks and pressure faces. A paralithic contact is at approximately 32 inches. Rainfall is approximately 10 inches. In other parts of the survey area, this soil has a natric horizon with pH 4.8 (1:1 H_2O) or pH 4.5 (saturated paste). See attached data sheet for more information at the type location elsewhere in this survey area. How do you classify this soil.

Typic Argixeroll, fine, montmorillonitic, thermic
Typic Argixeroll, fine, mixed, thermic
Natric Argixeroll, fine, montmorillonitic, thermic
Natric Argixeroll, fine, mixed, thermic
Typic Haploxeralf, fine, montmorillonitic, thermic
Typic Haploxeralf, fine, mixed, thermic
Typic Natrixeralf, fine, montmorillonitic, thermic
Typic Natrixeralf, fine, mixed, thermic,
Other --

NOTE: The grass along the road and on cutbanks between stops 1 and 2 is Fountain grass (Pennisetum Setaceum). It was imported for use as an ornamental and has since spread throughout the county.

Stop 2 Typic Chromoxererts, fine, montmorillonitic, thermic. No lab data available, moist color is 5YR3/2 throughout. Numerous slickensides and cracks throughout. Derived from calcareous marine sediments. Rainfall in this area is about 12 inches. Note the mobile home court and preparations for urban uses of this soil.

NOTE: Observe the avocado groves on the south side of Highway 8 on our way to Stop 3. The soils these avocadoes are being grown on are very similar to those we will observe at Stop 4 especially the granitic parent materials. The avocados are on thermic soils - Stop 5 is mesic.

Stop 3 Typic Rhodexeralf, fine, mixed, thermic. No lab data available. Argillic horizon has colors of 2.5YR3/6 dry and 2.5YR3/4 moist. Depth to paralithic contact of basic intrusive igneous rock (gabbro?) is approximately 22 inches. Soil at this site isclayey-skeletal in places. Note that this profile is a part of a mass soil slip which has moved the entire profile, including the weathered rock. Rainfall in this area is approximately 15 inches.

NOTE: Observe the geologic contacts on the left (north) as we proceed to stop 4. The temperature regime changes from thermic to mesic in the general vicinity of Highway 8 and the Sunrise Highway.

Stop 4 Classification Questionable.

Is this a complex of Entic Haploxeroll-Lithic Haploxeroll-Rock outcrop, a ruptic-lithic subgroup or some other type of unit and/or classification. Is the rock lithic, paralithic or C horizon or a complex of any or all of these. At this site we will discuss the classification, field recognition and mapping of these kinds of soils.

This type of landscape is similar to the one where we observed the avocados between site 2 and 3. How do we interpret these kinds of soils in the avocado-citrus belt, particularly for speciality crops.

Stop 5 Lunch at Chateau Basque Restaurant on old Highway 80 Bankhead
12:30pm Springs (Jacumba, CA)
($\pm$)

1:30pm Leave Jacumba (Note: stops 4 and 5 maybe reversed depending on timing, etc.)

Stop 6 Leave Highway 8 at Sunrise Highway. Meet with a representative of the Cleveland National Forest (U.S. Forest Service) at Vista Point. Observe and discuss Forest Service fuel management program in this area.

Stop 7 Proceed along Sunrise Highway to small Forest Service Park at crest of Mt. Laguna. At overview observe the desert portion of San Diego County.

NOTE: Observe fuel management program in the conifers. Also note - there are conifers in San Diego County.

NOTE: Stop 6 and/or 7 are tentative depending upon local weather, road conditions, and time available.

About 4:30pm Return to motel.

Depth (In.)	Horizon	1B1b Size class and particle diameter (mm) 3A1 — Total: Sand (2–0.05)	Total: Silt (0.05–0.002)	Total: Clay (< 0.002)	Sand: Very coarse (2–1)	Sand: Coarse (1–0.5)	Sand: Medium (0.5–0.25)	Sand: Fine (0.25–0.1)	Sand: Very fine (0.1–0.05)	Silt: 0.05–0.02	Silt: Int. III (0.02–0.002)	Int. II (0.2–0.02)	(2–0.1)	3A1a Carbonate clay	3A1a Non carbonate clay	1/ Coarse fragments 1A2a: > 2	2 – 19	19 - 76
		← Pct. of < 2 mm													→	Pct.	← Pct. of < 76 mm	→
0- 4	A1	34.2	52.3	13.5	5.0	7.4	5.1	9.4	7.3	12.7	39.6	25.2	26.9			13	13	-
4- 8	A2	26.0	54.4	19.6	3.4	6.0	3.9	6.8	5.9	8.7	45.7	18.3	20.1			5	5	-
8-18	B21t	16.3	31.8	51.9	0.4	0.9	1.1	6.7	7.2	8.5	23.3	20.4	9.1			-	-	-
18-23	B22t	55.8	28.6	15.6	5.5	11.8	7.3	18.7	12.5	12.8	15.8	36.6	43.3			-	-	-
23-31+	R																	

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N	6C2a Ext. Iron as Fe	6E1b Carbonate as $CaCO_3$	6G1d KCl ext. Al^{+++}	Bulk density: 4A1f 1/3 bar	Bulk density: 4A1h Oven dry	Bulk density	3B2 Cm	Water content	Water content: 4B1c 1/3 bar	Water content: 4B2 15 bar	4D1 Extensibility LEf	4D1 Extensibility LE	pH: 8C1b Saturated Paste	pH: 8C1a H_2O 1:1	pH: 8C1a H_2O 1:10
	Pct.	Pct.		Pct.	Pct.	meq/100g	g/cc	g/cc	g/cc		Pct.	Pct.	Pct.	Pct.	Pct.			
0- 4				1.6		-	1.38	1.41		0.93		18.7	6.7	0.7	0.7	6.1	6.2	
4- 8				1.4		0.4	1.63	1.68		0.97		18.4	7.7	1.0	1.0	5.0	5.2	
8-18				2.0		1.5	1.36	1.86		1.00		29.8	19.7	11.1	11.1	4.5	4.8	
18-23				1.7		0.9							9.8			4.2	5.3	
23-31+				1.5		0.2	2.15	2.21		1.00		8.6	6.2	1.0	1.0	5.7	6.2	

Depth (In)	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	6H2a Ext. Acidity	Cation Exch Capacity: 5A2a NaOAc	Cation Exch Capacity: 5A1a NH_4OAc	Water extract from saturated paste 8A1: 6N1a Ca	6O1a Mg	6P1a Na	6Q1a K		6I1a CO_3	6J1a HCO_3	6K1a Cl	6L1b SO_4	8A1a Electrical conductivity
	← meq/100 g							→	← meq/liter								→	mmho/cm
0- 4	8.3	2.8	2.0	0.8	13.3	4.2	16.1	11.6	3.0	2.0	1.0	0.2		-	1.7	2.1		0.76
4- 8	5.2	6.3	4.8	0.2	16.5	4.8	17.2	13.3	0.7	0.3	1.2	0.1		-	0.6	1.3		0.37
8-18	12.5	20.1	5.8	0.5	38.9	9.8	45.6	39.6	0.4	0.4	4.1	0.1		-	0.4	2.4		0.57
18-23	8.5	12.8	5.6	0.1	27.0	7.6	30.0	26.3	0.5	0.6	5.6	tr.		-	0.2	4.2		0.78
23-31+	6.5	10.6	5.4	0.2	22.7	4.0	23.0	20.8	0.6	1.0	7.9	0.1		-	0.4	7.6		1.26

Depth (in.)	8A Water at Saturation	Exch. bases: 5B3b Ca	Exch. bases: 5B3b Mg	Exch. bases: 5B1b Na	5D2 Exchangeable Na	5E SAR	Base saturation NH_4OAc	Clay mineralogy (<0.002 mm) 3A1: Mont.	2:1 to 2:2 intergrade	Mica 7A2	Kaolin.	DTA Whole soil % kaolinite
	Pct.	← meq./100 g.		→	Pct.		Pct.	← X-ray			→	
0- 4	31.7	8.2	2.7	2.0	12	0.6	100+	xx			xxx	
4- 8	26.6	5.2	6.3	4.8	28	1.7	100+	xx			xxx	14
8-18	65.2	12.5	20.1	5.5	12	6.5	98	xx	x		xx	20
18-23	35.9	8.5	12.8	5.4	18	7.5	100+	xx	x		xx	19
23-31+	29.1	6.5	10.6	5.2	23	8.8	100+	xx	x		xx	18

1/ From characterization sample (5 kg.). The R horizon was ground whole.

- = looked for but not found
t = trace
x = small
xx = moderate
xxx = abundant
xxxx = dominant

The following are pages of interest taken directly from the San Diego County published soil survey. Included are (1) General description of the County, (2) Climate, (3) Farming, (4) General Soil Map, (5) Formation of Soils, and (6) Land Resource Areas. These sections should provide a fair overview of San Diego County and the various areas we will be passing through.

SOIL SURVEY OF THE SAN DIEGO AREA, CALIFORNIA, PART I

(San Diego County excluding the Anza-Borrego and Cuyamaca State Parks)

BY ROY H. BOWMAN

SOILS SURVEYED BY ROY H. BOWMAN, ALAN A. HOUSE, GERALD KESTER, DAVID D. ESTRADA, JOHN K. WACHTELL, SOIL CONSERVATION SERVICE; GERALD L. ANDERSON, FOREST SERVICE; AND PAUL V. CAMPO, UNITED STATES MARINE CORPS

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE AND FOREST SERVICE, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION, THE UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, THE DEPARTMENT OF THE NAVY, UNITED STATES MARINE CORPS, THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, AND THE COUNTY OF SAN DIEGO PLANNING DEPARTMENT

SAN DIEGO COUNTY, the most southwesterly county in the continental United States, is bounded on the west by the Pacific Ocean, on the north by Orange and Riverside Counties, on the east by Imperial County, and on the south by Mexico. The county is roughly 70 miles from east to west and 60 miles from north to south. The elevation ranges from sea level to 6,533 feet.

The Area surveyed (fig. 1) is approximately 2,204,880 acres. It excludes the Anza-Borrego and the Cuyamaca State Parks but includes a small part of Riverside County north of Palomar Mountain. The physiography, the climate, and the vegetation vary widely.

The coastal plains rise sharply to nearly level terraces, dissected terraces, and rolling hills that support a natural cover of coastal chaparral and grassland. In the narrow winding valleys, oak is the dominant vegetation. In the center of the Area are the foothills, the narrow intermediate valleys, the mountains, and the plateaus of the Peninsular Range province. Chaparral, open woodland, and isolated areas of open grassland make up the typical plant cover. The eastern part of the Salton Basin province is one of wide valleys separated by low irregular hills and mountains of multicolored beds of sandstone, shale, and conglomerate. The vegetation in this part is mainly a sparse cover of desert shrubs, cactus, and bunchgrass.

The climate ranges from mild marine along the coast to hot arid in the desert.

Since World War II, suburban expansion has transformed much of the farmland in the western third of the Area into urban-fringe areas. As a result, taxes and the cost of labor and real estate have increased out of proportion to farm income. Another factor that has added to the increased overhead is the high cost of importing water for irrigation from the Colorado River. Consequently, the only crops grown are those that have high gross returns and do not compete with crops grown in other farming areas, or semitropical crops that are limited to a relatively frost-free climate, for example, avocados, citrus, flowers, tomatoes, truck crops, and other specialty crops.

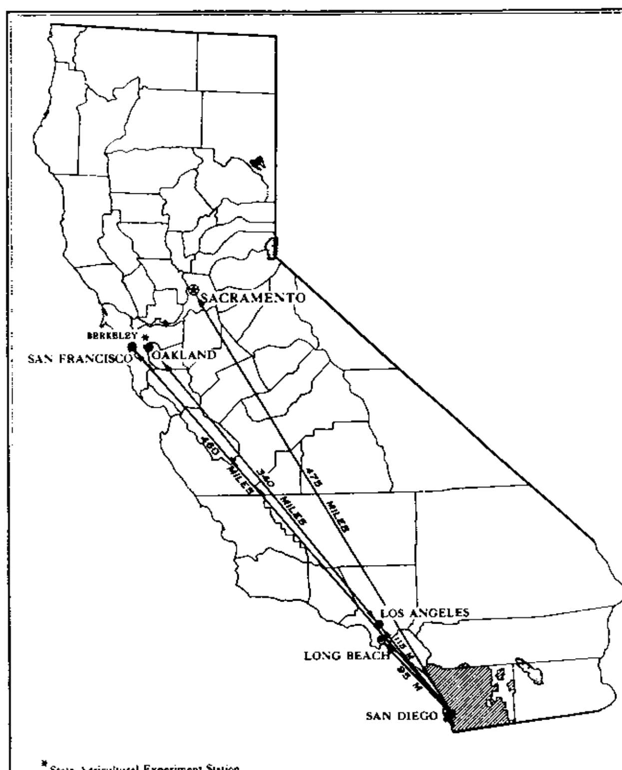


Figure 1.--Location of San Diego Area in California.

Poultry raising and dairying are important enterprises but occupy a very small acreage. No feed is raised on these farms. Dry lots, instead of pastures, are used in dairying. On poultry farms, the laying hens are caged throughout their productive life.

Although 400,000 acres of the Area is used for range, ranching is not an important enterprise. Much of the range is chaparral vegetation, which yields low-quality forage.

CLIMATE[1]

Climatic data for the whole of San Diego County are discussed in this section, although the Anza-Borrego and the Cuyanaca State Parks were not covered by this soil survey (see figure 1).

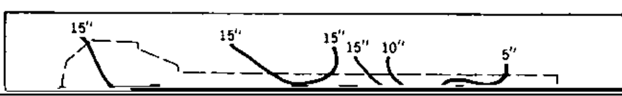
The county has warm, dry summers and mild winters. It is made up of four physiographic provinces--the Coastal Plains, the Foothills, the Mountains, and the Desert. Temperature and precipitation data for each of these areas are given in table 1.

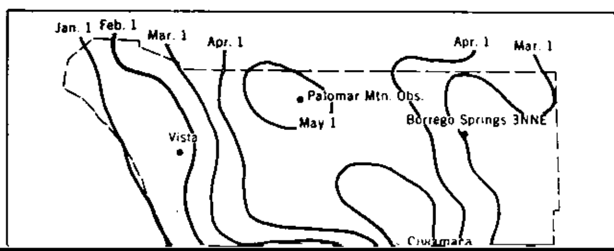
The Coastal Plains has the most equable climate of any area in the county; it has only light frost in winter. The Foothills have more variation in temperature and more precipitation than the Coastal Plains. The Mountain area has a wider range of temperature and receives more precipitation than either the Coastal Plains or the Foothills. The mean annual temperature is between 54° and 58° F. There is generally light snowfall in winter, but snow seldom stays on the ground for more than a few days. The Desert has the greatest variation in temperature and receives the least amount of precipitation of all the areas in the county.

Rainfall is heaviest during the period November to April and is infrequent in summer. The average total precipitation on the Coastal Plains is about 13 inches, and in the Mountains about 25 inches. The amount of rainfall diminishes rapidly down the east slope of the Mountains and averages 5 inches in the Desert (fig. 2). Humidity is fairly high on the Coastal Plains in summer because of fog along the coast and is fairly low in the Desert on summer afternoons. The rest of the year it is moderate throughout the county.

Moderate temperatures prevail on the Coastal Plains. The growing season, or the period between the last freezing temperature in spring (fig. 3) and the first in fall (fig. 4), is 280 to 360 days. Sloping areas, which have the best air drainage and the least amount of frost, are desirable for avocados, citrus, and other frost-sensitive crops.

In the Foothills the growing season is 220 to 340 days. The mean annual temperature is between 59° and 63°. The average date of the first freeze in fall is December 1, and the last in spring February 1. Sloping areas, which have better air drainage and less frost than level areas, are desirable for avocados, citrus, and other frost-sensitive crops.





In the Mountains the growing season is 150 to 200 days, which is the shortest in the county. The average dates of the first and the last freeze are November 1 and May 1, respectively. The mean maximum temperature in July is between 85° and 95°, and the mean minimum in January between 28° and 34°.

The growing season in the Desert is 210 to 260 days. The first freeze occurs about December 1, and the last about March 1. The mean maximum temperature in July is between 100° and 105°, and the mean minimum in January is 36°.

Winds are generally light; in fact, less than 8 miles per hour 64 percent of the time. Except for persistent westerly winds along the coast during summer afternoons, they vary in direction. Strong winds are associated with the east side of the Mountains, which slopes down to the Desert. The strongest winds are usually associated with occasional migrant storms that cross the county in winter.

Three or four times a year, usually in fall or in winter, pressure conditions cause a fairly strong, gusty flow of air from the north or east. This air is usually dry and at times is unseasonably warm.

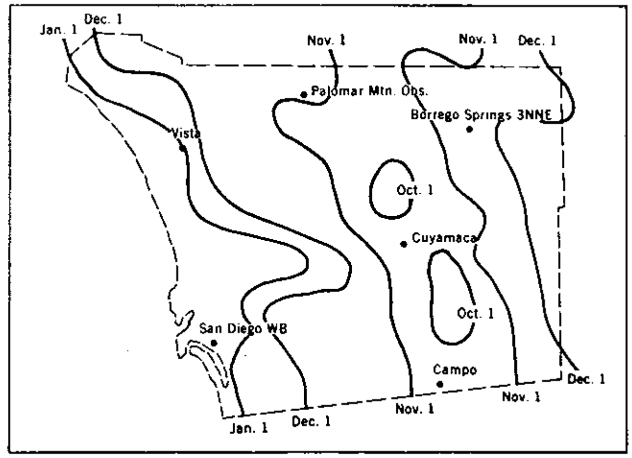


Figure 4.--Average date of first 32° temperature in fall.

FARMING

The Spanish introduced farming into San Diego County in 1769 with the establishment of Mission San Diego de Alcala. Farming was limited to teaching the Indians to raise food for the Mission and for themselves. Primitive methods of irrigation were used during the long, dry summer. Mission San Luis Rey de Francia was established in 1798. Here too, limited farming was practiced to meet Mission needs.

The Missions also introduced livestock. In 1800, they had 450 head of cattle, 1,600 sheep, 148 horses, and 14 mules. By 1828, they had a total of 58,685 head of livestock. The main products to be marketed were hides and tallow.

Early in the 1800's, the land was taken from the Missions by the Spanish Governor of Alta California, diverted into Mexican land grants, and given to individuals.

In 1846, California became a territory of the United States. Production of beef became the most important industry. In 1885, railway service to [illegible]

olives, and citrus expanded. Dairying and poultry raising enterprises soon followed.

In the 1920's, avocados were introduced. With the development of irrigation projects, land values, taxes, and water assessments increased the cost of farming and prompted the change from grapes and olives to avocados and citrus, which are of greater cash value.

Currently, farming is dominated by intensive specialized production of vegetables, fruits, flowers, eggs, and milk. Large acreages have executive-type management, specialized equipment, and highly organized labor skills, all of which result in very high gross returns per acre. Egg and milk production resembles an assembly-line, factory-type operation. Production per man-hour is very high. Only a small amount of land is needed in these operations. All feed is purchased from feed companies, and all products are moved rapidly to market.

For the past 15 years, large areas have been used for urban development. The coastal areas from [illegible]

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA FOR FOUR WEATHER STATIONS IN SAN DIEGO AREA, CALIF.

[County of San Diego, Natural Resources Annual Report for years 1958-67. Data from National Weather Service]

Coastal plain: San Diego, Calif.
[Elevation 19 feet]

Month	Temperature						Precipitation
	Mean high	Mean low	Monthly mean	Highest	Lowest	Days 32° F. or below	Total
	°F.	°F.	°F.	°F.	°F.	No.	In.
January------	66.3	47.1	56.7	83	31	0.1	1.29
February-----	66.3	48.9	57.6	85	38	0	1.45
March--------	66.3	51.0	58.7	88	42	0	1.14
April--------	71.9	55.6	63.8	86	47	0	1.65
May----------	69.1	57.4	63.3	91	48	0	0.15
June---------	70.7	60.0	65.4	85	51	0	0.06
July---------	75.6	63.9	69.8	93	57	0	0.03
August-------	78.0	66.2	72.1	89	61	0	0.02
September----	77.4	64.0	70.7	111	56	0	0.30
October------	75.9	59.5	67.7	107	48	0	0.14
November-----	69.9	53.0	61.5	97	38	0	1.53
December-----	66.5	48.1	57.3	88	35	0	1.61
Year-------	71.2	56.2	63.2	111	31	0.1	9.34

Foothills: Escondido, Calif.

[Elevation 700 feet]

January------	66.9	37.8	52.4	86	23	7.6	1.67
February-----	67.2	40.4	53.8	92	28	2.5	2.30
March--------	68.3	42.7	55.5	89	29	1.0	2.07
April--------	73.1	46.6	59.9	97	35	0	1.71
May----------	75.6	51.1	63.3	97	39	0	0.24
June---------	80.1	55.0	67.6	96	41	0	0.07
July---------	87.8	58.5	73.1	105	47	0	0.07
August-------	88.5	61.1	74.9	103	50	0	0.05
September----	84.8	57.6	71.2	105	45	0	0.39
October------	80.2	52.0	66.1	101	38	0	0.31
November-----	71.3	44.2	57.8	93	25	0.9	2.26
December-----	67.3	39.6	53.5	89	26	3.5	2.35
Year-------	75.1	48.9	62.4	105	23	15.5	13.49

Mountains: Palomar Observatory, Calif.
[Elevation 5,515 feet]

January------	54.6	33.9	44.3	78	13	1/ 11.8	2.95
February-----	54.9	34.1	44.5	76	15	12.1	3.92
March--------	56.6	34.4	45.5	82	16	14.1	3.61
April--------	62.5	39.1	50.8	83	22	9.5	3.77
May----------	68.5	43.9	55.2	88	24	3.2	0.35
June---------	77.0	54.4	64.7	93	28	0.9	0.11
July---------	84.2	60.8	72.6	95	49	0	0.27
August-------	84.8	60.8	72.8	94	38	0	0.37
September----	79.9	54.4	67.2	93	35	0	0.73
October------	74.3	49.2	61.8	90	24	0.9	0.40
November-----	61.8	39.5	50.7	80	17	5.8	4.49
December-----	56.3	35.6	46.0	80	10	1/ 8.6	5.37
Year-------	68.1	45.0	56.3	95	10	66.9	26.34

Desert: Borrego Springs, Calif.
[Elevation 500 feet]

Month	Temperature						Precipitation
	Mean high	Mean low	Monthly mean	Highest	Lowest	Days 32° F. or below	Total
	°F.	°F.	°F.	°F.	°F.	No.	In.
January------	69.5	36.7	53.1	89	20	7.9	0.25
February-----	73.4	41.8	57.6	91	25	2.3	0.43
March--------	76.9	45.9	61.4	93	26	0.6	0.26
April--------	83.8	51.4	67.6	102	37	0	0.14
May----------	90.4	56.9	73.7	111	40	0	0.02
June---------	98.9	63.7	81.3	115	48	0	0.00
July---------	105.1	70.8	88.0	117	55	0	0.13
August-------	103.5	71.5	87.5	114	56	0	0.26
September----	1/ 88.6	1/ 56.5	1/ 72.6	1/ 111	1/ 42	0	0.21
October------	1/ 81.5	1/ 49.9	1/ 65.7	1/ 105	1/ 37	0	0.35
November-----	77.0	45.9	61.4	97	23	0.9	0.61
December-----	69.8	38.7	54.3	89	21	3.8	0.61
Year-------	84.9	52.5	68.7	117	20	15.5	3.27

1/ Based on 9 years reporting.

The general soil map (see box containing detailed soil maps) shows, in color, the soil associations in the San Diego Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an Area, who want to compare different parts of an Area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is also useful in determining the value of an association for a watershed, for wildlife habitat, for engineering projects, for recreational areas, and for community development. A general soil map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect managment.

The San Diego Area has been divided into four major physiographic provinces--the Desert, the Mountains, the Foothills, and the Coastal Plains. These provinces reflect differences in climate, soils, and land use. The four provinces are outlined on the general soil map and are described in detail in the section "Formation, Morphology, and Classification of the Soils."

The 34 soil associations in the San Diego Area have been assigned to 8 groups. The grouping is based on soil characteristics and qualities and on location of the associations in the specified physiographic province. All groups and associations are described in the following pages.

Group I. Excessively Drained to Well-Drained, Nearly Level to Moderately Sloping Very Gravelly Sands to Silt Loams on Alluvial Fans in Desert Areas

The soils in this group are excessively drained to well-drained very gravelly sands, loamy coarse sands, sandy loams, and silt loams. They formed in material derived from acid igneous rock and mica schist. Slopes range from 0 to 9 percent.

The elevation ranges from 100 to 2,500 feet. The average annual rainfall is between 3 and 8 inches, and the average annual air temperature between 70° and 74° F. The frost-free season is 240 to 275 days. The vegetation consists of desert shrubs, cactus, and scattered annual grasses and forbs.

These soils are used for irrigated cotton, dates, alfalfa, citrus, and pasture. Unless irrigation water is available, they produce only a limited amount of forage for livestock.

Three associations of the San Diego Area are in this group. They represent all of the cultivated acreage in the Desert and make up about 5 percent of the Area.

1. Mecca-Indio Association

Well-drained sandy loams and silt loams on alluvial fans, subject to occasional flooding and deposition; 0 to 5 percent slopes

This association is made up of soils that developed in alluvium derived from acid igneous rock and mica schist. It occurs in the Desert. The elevation ranges from 100 to 2,500 feet. The mean annual precipitation is between 3 and 8 inches, and the mean annual air temperature between 70° and 74° F. The frost-free season is 220 to 275 days. The vegetation consists mostly of desert shrubs, cactus, and annual grasses.

This association occupies about 1 percent of the San Diego Area. Mecca soils make up about 50 percent of the association, and Indio soils about 40 percent. Rositas and Carrizo soils and small areas of moderately to strongly saline Indio soils make up the remaining 10 percent.

Mecca soils are brown and yellowish-brown coarse sandy loams, sandy loams, or fine sandy loams. Indio soils are pale-brown silt loam to a depth of about 45 inches, and below this, pale-brown fine sandy loam. Both soils are slightly saline. Free water is seldom close enough to the surface to create a problem.

Irrigated areas are used for crops, most commonly cotton, dates, alfalfa, and small grain. Nonirrigated areas are used for range.

2. Rositas-Carrizo Association

Somewhat excessively drained and excessively drained loamy coarse sands to very gravelly sands on alluvial fans; 0 to 2 percent slopes

This association is made up of soils that developed in alluvium derived from acid igneous rock and mica schist. It occurs in the Desert. The elevation ranges from 100 to 2,000 feet. The mean annual precipitation is between 4 and 7 inches, and the mean annual air temperature between 68° and 74° F. The frost-free season is 210 to 270 days. The vegetation consists mostly of desert shrubs, cactus, and annual grasses.

This association occupies about 2 percent of the San Diego Area. Rositas soils make up about 50 percent of the association, and Carrizo soils about 35 percent. Mecca soils, Indio soils, and sand dunes make up the remaining 15 percent.

Rositas soils are somewhat excessively drained, light brownish-gray loamy coarse sands and fine sands. They have a substratum of pale-brown fine gravelly loamy coarse sand to fine sand. Carrizo soils are excessively drained, very pale brown very gravelly sands. They have a substratum of very pale brown very gravelly coarse sand.

Carrizo soils are marginal for irrigated farming, but they provide a good source of sand and gravel for construction purposes. Irrigated areas of

Rositas soils are used for vineyards, citrus, pasture, and alfalfa. Nonirrigated areas are used for range. Some areas are subject to occasional overflow.

3. Rositas-Carrizo Association

4. Mottsville-Bull Trail Association

Excessively drained to well-drained loamy coarse sands and sandy loams on alluvial fans and in basins; 2 to 15 percent slopes

...tion is made up of soils that devel-

Group III. Excessively Drained to Moderately Well Drained, Nearly Level to Moderately Sloping Loamy Sands to Clays on Alluvial Fans and Alluvial Plains in Foothill and Coastal Plain Areas

The soils in this group are excessively drained

rock. It is on the Coastal Plains and in the Foothills. The elevation ranges from sea level to 2,000 feet. The mean annual precipitation is between 10 and 18 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is

8. Ramona-Placentia Association

Well drained and moderately well drained sandy loams that have a subsoil of sandy clay loam to sandy clay over granitic alluvium; 2 to 15 percent slopes

This association is made up of soils that developed in alluvium derived from granitic rocks. It is in the Foothills. The elevation ranges from 200 to 1,800 feet. The mean annual precipitation is between 14 and 18 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 260 to 320 days. The vegetation consists mostly of soft chess, wild oats, filaree, barley, chamise, annual forbs, and a few scattered oaks.

This association occupies about 2 percent of the San Diego Area. Ramona soils make up about 55 percent of the association, and Placentia soils about 35 percent. Bonsall, Fallbrook, and Visalia soils make up the remaining 10 percent.

Ramona soils are well drained. They have a surface layer of yellowish-brown sandy loam and gravelly sandy loam and a subsoil of brown sandy clay loam. Placentia soils are moderately well drained. They have a surface layer of brown sandy loam and a subsoil of brown sandy clay. Both soils overlie yellowish-brown coarse sandy loam to sandy clay loam.

These soils are used for citrus, pasture, dry-farmed grain, and range. Urban use is increasing.

9. Marina-Chesterton Association

Somewhat excessively drained to moderately well drained loamy coarse sands and fine sandy loams that have a subsoil of sandy clay over a hardpan; 2 to 15 percent slopes

This association is made up of soils that developed in ferruginous, windworked, weakly consolidated sand. It occurs on broad rolling ridges parallel to the coast. The elevation ranges from sea level to 400 feet. The mean annual precipitation is between 10 and 14 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 330 to 350 days. The winter growing season has infrequent light frosts. Semitropical plants and winter vegetables are seldom damaged. The vegetation consists mostly of chamise, sumac, black sage, flattop buckwheat, and annual grasses and forbs.

This association occupies about 2 percent of the survey area. Marina soils make up about 45 percent of the association, and Chesterton soils about 35 percent. Las Flores and Huerhuero soils and Coastal beaches make up the remaining 20 percent.

Marina soils are somewhat excessively drained. They have a surface layer of dark yellowish-brown loamy coarse sand and a subsoil of strong-brown loamy coarse sand. Chesterton soils are moderately well drained. They have a surface layer of brown fine sandy loam, a subsoil of mottled red, brown, and gray sandy clay, and below this, an iron-silica cemented hardpan.

The soils of this association are used for truck crops, flowers, citrus, and avocados. Urban use is increasing along the coast.

10. Huerhuero-Stockpen Association

Moderately well drained loams to gravelly clay loams that have a subsoil of clay or gravelly clay; 0 to 9 percent slopes

This association is made up of soils that developed on marine terraces in sandy to clayey marine sediments. It occurs on the Coastal Plains. The elevation ranges from sea level to 400 feet. The mean annual precipitation is between 10 and 12 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 300 to 350 days. The vegetation consists of tarweed, Russian-thistle, wild oats, red brome, and other annual grasses and forbs.

This association occupies about 2 percent of the survey area. Huerhuero soils make up about 75 percent of this association, and Stockpen soils about 15 percent. Las Flores soils, Olivenhain soils, and Urban land make up the remaining 10 percent.

Huerhuero soils have a surface layer of brown loam and a subsoil of brown clay. Stockpen soils have a surface layer of light-gray gravelly clay loam and a subsoil of gray gravelly clay. Both soils overlie yellowish-brown loamy sand to olive-gray clay.

These soils are used for truck crops, flowers, housing developments, and range. Damage from winter frost is slight.

11. Redding Association

Well-drained cobbly loams and gravelly loams that have a gravelly clay subsoil over a hardpan; 2 to 9 percent slopes

This association is made up of undulating to gently rolling soils that formed on gravelly marine terraces. It occurs on the Coastal Plains. Typically, there are many broad-based hummocks, locally called mimamounds. The elevation ranges from 200 to 500 feet. The mean annual precipitation is between 10 and 15 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 290 to 330 days. The vegetation consists mostly of chamise, flattop buckwheat, sumac, scrub oak, and annual forbs and grasses.

This association occupies about 1 percent of the survey area. Redding soils make up about 90 percent of the association. Olivenhain soils, Chesterton soils, and small areas of Terrace escarpments make up the remaining 10 percent.

Redding soils have a surface layer of light-brown cobbly loam and gravelly loam, a subsoil of red gravelly clay, and below this, an iron-silica cemented hardpan. The pan is not uniform or continuous. Following normal rainy periods, water is ponded in areas between the mounds.

These soils are of little value for farming and ranching. Open areas are mainly idle. Industrial and urban developments occupy large areas and are continuing to expand in the area of Clairemont and Miramar.

12. Redding-Olivenhain Association

Well-drained gravelly loams and cobbly loams that have a subsoil of gravelly clay and very cobbly clay over a hardpan or cobbly alluvium; 9 to 50 percent slopes

This association is made up of soils that developed on old gravelly and cobbly marine terraces deeply dissected by numerous drainageways. It occurs on the Coastal Plains. It is characterized by tortuous divides and deep V-shaped valleys that have steep side slopes. The elevation ranges from 100 to 600 feet. The mean annual precipitation is between 10 and 16 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 290 to 330 days. The vegetation consists of chamise, sumac, flattop buckwheat, sugarbush, and annual forbs and grasses.

This association occupies about 4 percent of the San Diego Area. Redding soils make up about 45 percent of the association, and Olivenhain soils about 40 percent. Huerhuero soils, Gaviota soils, and Terrace escarpments make up the remaining 15 percent.

Redding soils have a surface layer of light-brown cobbly loam and gravelly loam, a subsoil of red gravelly clay, and, below this, an iron-silica cemented hardpan. The hardpan is not continuous; generally it does not occur at the base of steep slopes. Olivenhain soils have a surface layer of brown cobbly loam and a subsoil of reddish-brown very cobbly clay. They are underlain by cobbly loam alluvium.

These soils are used for watershed and military testing grounds. A limited acreage is in range. In a few small areas, the landscape has been reshaped and used for urban developments. Urban development is difficult because of the gravelly and cobbly texture, the steep topography, and the hardpan.

Group V. Excessively Drained to Well-Drained, Moderately Sloping to Very Steep Loamy Coarse Sands to Loams on Uplands in Mountainous Areas

The soils in this group are excessively drained to well-drained loamy coarse sands to loams. They formed in material derived from mica schist, gabbro, granodiorite, and quartz diorite. Slopes range from 5 to 75 percent. In many areas these soils are eroded. In most areas rock outcrops or stones cover 2 to 10 percent of the surface.

The elevation ranges mainly from 2,000 to 6,000 feet. Some peaks rise above 6,000 feet. The average annual precipitation is between 12 and 38 inches, and the average annual air temperature between 53° and 58° F. The frost-free season is 135 to 230 days. The vegetation consists mainly of coniferous woodland or chaparral and an understory of annual grasses and forbs.

These soils are used for range, wildlife habitat, and watershed. Some small areas are used for apple and pear orchards. Others are used as recreational areas and cabin sites.

Seven of the associations in the San Diego Area are in this group. They occupy about 26 percent of the Area.

13. Holland-Boomer Association, Stony

Well-drained stony fine sandy loams and stony loams that have a subsoil of sandy clay loam and stony clay loam over weathered micaceous schist and decomposed gabbro; 9 to 60 percent slopes

This association is made up of strongly sloping to very steep soils that developed in material weathered in place from mica schist and gabbro. It occurs in the Mountains. The elevation ranges from 3,200 to 5,600 feet. The mean annual precipitation is between 25 and 38 inches, and the mean annual air temperature between 53° and 56° F. The frost-free season is 135 to 200 days. The vegetation is chiefly coniferous woodland, shrubs, and an understory of annual and perennial grasses.

This association occupies about 3 percent of the San Diego Area. Holland soils make up about 50 percent of the association, and Boomer soils about 35 percent. Sheephead soils, La Posta soils, and rock land make up the remaining 15 percent.

Holland soils have a surface layer of yellowish-brown stony fine sandy loam and fine sandy loam and a subsoil of brown sandy clay loam. Below this is weathered micaceous schist. Boomer soils have a surface layer of reddish-brown stony loam and loam and a subsoil of yellowish-red stony clay loam. Below this is decomposed gabbro. A few boulders and rock outcrops occur throughout the association.

These soils are used mainly for range, woodland, wildlife habitat, and watershed. A few small areas are used for apple and pear orchards. Wooded areas are used as recreational areas and as sites for summer cottages.

14. Crouch Association, Rocky

Well-drained coarse sandy loams over weathered granodiorite; 9 to 30 percent slopes

This association is made up of soils that developed in material weathered from granodiorite. It occurs in the Mountains. The elevation ranges mainly from 3,000 to 6,000 feet. Some peaks rise above 6,000 feet. The mean annual precipitation is between 20 and 35 inches, and the mean annual air temperature between 53° and 55° F. The frost-free season is 135 to 175 days. The vegetation consists of open stands of mixed coniferous and deciduous trees and an understory of shrubs and grasses.

This association occupies 2 percent of the San Diego Area. Crouch soils make up about 90 percent of the association. Holland soils, La Posta soils, and Loamy alluvial land make up the remaining 10 percent.

Crouch soils have a surface layer of dark grayish-brown coarse sandy loam and a subsoil of yellowish-brown sandy loam. They overlie weathered granodiorite that is several feet thick. Rock outcrops, stones, and boulders cover about 2 to 10 percent of the surface.

These soils are used mainly for range, wildlife habitat, and watershed. The woodland on this association is of little or no importance in the production of timber. Wooded areas are used as recreational areas and as sites for summer cottages.

15. Crouch Association, Rocky

Well-drained coarse sandy loams over weathered granodiorite; 30 to 75 percent slopes

This association is made up of soils that developed in material derived from granodiorite. It occurs in the Mountains. The elevation ranges from 3,000 to 8,000 feet. The mean annual precipitation is between 20 and 35 inches, and the mean annual air temperature between 53° and 55° F. The frost-free season is 135 to 175 days. The vegetation consists of open stands of mixed coniferous and deciduous trees and an understory of shrubs and grasses.

This association occupies 2 percent of the San Diego Area. Crouch soils make up about 85 percent of the association. La Posta soils, Sheephead soils, and areas of rock land make up the remaining 15 percent.

Crouch soils have a surface layer of dark grayish-brown coarse sandy loam and a subsoil of yellowish-brown sandy loam. They overlie weathered granodiorite that is several feet thick. Rock outcrops and boulders cover about 2 to 10 percent of the surface.

These soils are used mostly for range, wildlife habitat, watershed, and recreational areas. The woodland on this association is of little or no importance in the production of timber.

16. La Posta-Kitchen Creek Association, Rocky, Eroded

Somewhat excessively drained loamy coarse sands over decomposed granodiorite; 5 to 15 percent slopes

This association is made up of soils that developed in material derived from granitic rock. It occurs on uplands in the Mountains. The elevation ranges from 2,000 to 4,500 feet. The mean annual precipitation is between 12 and 20 inches, and the mean annual air temperature between 56° and 58° F. The frost-free season is 160 to 190 days. The vegetation consists of chaparral, mainly chamise, red shank, scrub oak, and flattop buckwheat.

This association occupies about 2 percent of the San Diego Area. La Posta soils make up about 70 percent of the association, and Kitchen Creek about 20 percent. Mottsville and Tollhouse soils make up the remaining 10 percent.

La Posta soils have a surface layer of grayish-brown loamy coarse sand and a substratum of brown loamy coarse sand. Below this is decomposed granodiorite. Rock outcrops and boulders cover 2 to 10 percent of the surface. Kitchen Creek soils have a surface layer of dark-brown loamy coarse sand and a subsoil of pale-brown coarse sandy loam. Below this is decomposed granodiorite.

These soils are used mainly for range, wildlife habitat, and watershed. Large areas would be suitable for farming or for housing developments if water could be made available.

17. Tollhouse-La Posta-Rock Land Association, Eroded

Excessively drained and somewhat excessively drained coarse sandy loams and loamy coarse sands over granitic rock, and areas of rock land; 9 to 65 percent slopes

This association is made up of soils that developed in material derived from decomposed granodiorite. It occurs on uplands in the Mountains. The elevation ranges from 2,000 to 5,000 feet. The mean annual precipitation is between 15 and 20 inches, and the mean annual air temperature between 56° and 58° F. The frost-free season is 140 to 190 days. The vegetation is mainly chaparral and a few annual grasses and forbs.

This association occupies about 9 percent of the San Diego Area. Tollhouse soils make up about 45 percent of the association, La Posta soils about 35 percent, and Acid igneous rock land about 10 percent. Sheephead and Mottsville soils make up the remaining 10 percent.

Tollhouse soils are excessively drained. They have a surface layer of dark grayish-brown coarse sandy loam that is underlain by hard granitic rock. La Posta soils are somewhat excessively drained. They have a surface layer of grayish-brown loamy coarse sand and a substratum of brown loamy coarse sand that is underlain by weathered granodiorite. Rock land consists of areas where 50 to 90 percent of the surface is covered with boulders and outcrops of acid igneous rock. Very shallow soil material occurs in pockets between the rocks.

The soils of this association are used mainly for range, watershed, and wildlife habitat.

18. Sheephead Association, Rocky

Well-drained cobbly fine sandy loams over fractured mica schist; 9 to 65 percent slopes

This association is made up of soils that developed in material derived from mica schist. It occurs in the Mountains. The elevation ranges from

Group VI. Excessively Drained to Moderately Well Drained, Gently Sloping to Very Steep Sandy Loams to Silt Loams on Uplands in Foothill Areas

The soils in this group are excessively drained to moderately well drained sandy loams to silt loams that have a coarse sandy loam to clay subsoil. They are derived from granitic rock, gabbro, tonalite, metavolcanic rock, and metasedimentary rock. Rock

21. Fallbrook-Vista Association, Rocky

Well-drained sandy loams and coarse sandy loams that have a subsoil of sandy clay loam and sandy loam over decomposed granodiorite; 9 to 30 percent slopes

This association is made up of soils that devel

23. Cieneba-Fallbrook Association, Very Rocky

Excessively drained to well-drained coarse sandy loams and sandy loams that have a sandy clay loam subsoil over decomposed granodiorite; 9 to 75 percent slopes loam, a subsoil of reddish-brown stony clay loam, and below this, weathered metavolcanic rock.

These soils are used chiefly for range, watershed, and wildlife habitat.

25. Exchequer-San Miguel Association, Rocky

Well-drained silt loams over metavolcanic rock; 30 to 75 percent slopes

This association is made up of soils that developed in hard metavolcanic rock. It occurs in the Foothills. The elevation ranges from 400 to 3,300 feet. The mean annual precipitation is between 13 and 20 inches, and the mean annual air temperature between 59° and 62° F. The frost-free season is 240 to 280 days. The vegetation is mainly chaparral, consisting of chamise, ceanothus, flattop buckwheat, and California sagebrush.

This association occupies about 2 percent of the San Diego Area. Exchequer soils make up about 45 percent of the association, and San Miguel soils about 45 percent. Cieneba soils, Friant soils, and rock land make up the remaining 10 percent.

Exchequer soils have a surface layer of yellowish-red silt loam and are underlain by hard metavolcanic rock. San Miguel soils have a surface layer of light yellowish-brown silt loam, a subsoil of strong-brown clay, and below this, hard metavolcanic rock. Rock outcrop covers 2 to 10 percent of the surface.

These soils are used for range and watershed.

26. Friant-Escondido Association, Eroded

Well-drained fine sandy loams and very fine sandy loams over metasedimentary rock; 30 to 70 percent slopes

This association is made up of soils that developed in material weathered from relatively hard metasedimentary rock. It occurs in the Foothills. The elevation ranges from 400 to 3,500 feet. The mean annual precipitation is between 12 and 20 inches, and the mean annual air temperature between 59° and 62° F. The frost-free season is 240 to 310 days. The vegetation consists of California sagebrush, flattop buckwheat, white sage, a few scattered oaks, and annual grasses and forbs.

This association occupies 3 percent of the San Diego Area. Friant soils make up about 65 percent of the association, and Escondido soils about 20 percent. Cieneba soils, Exchequer soils, Fallbrook soils, and small areas of rock land make up the remaining 15 percent.

Friant soils have a surface layer of brown fine sandy loam. Below this is gray, hard, fine-grained metasedimentary rock. Escondido soils have a surface layer of dark-brown very fine sandy loam, a subsoil of brown very fine sandy loam, and below this, hard metasedimentary rock.

These soils are used mainly for range and watershed. Small selected areas of the deeper soils are used for citrus orchards and field crops.

Group VII. Well Drained and Moderately Well Drained, Moderately Sloping to Very Steep Loamy Fine Sands to Clays on Uplands in Coastal Plain Areas

The soils in this group are well drained and moderately well drained loamy fine sands to clays. They formed in material derived from marine sandstone and shale and breccia. In some places the soils that have a surface layer of loamy fine sand and loam have a sandy clay and clay subsoil. Slopes range from 5 to 75 percent.

The elevation ranges from near sea level to 1,800 feet. The average annual rainfall is between 10 and 16 inches, and the average annual air temperature between 60° and 62° F. The frost-free season is 280 to 350 days. The vegetation consists of annual grasses and forbs and scattered shrubs. Shrubs are predominant in areas of shallow or eroded soils.

These soils are used for truck crops, citrus, dryfarmed grain, range, watershed, and wildlife habitat. Urban and industrial uses are increasing.

Five associations of the San Diego Area are in this group. They represent 8 percent of the Area.

27. Diablo-Altamont Association

Well-drained clays; 5 to 15 percent slopes

This association is made up of soils that developed in material derived from soft marine sandstone and shale. It occupies rolling uplands on the Coastal Plains. The elevation ranges from 100 to 600 feet. The mean annual precipitation is between 10 and 14 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 300 to 340 days. The winter growing season has only light frost. The vegetation consists of annual grasses and forbs and small thickets of brush.

This association occupies about 1 percent of the San Diego Area. Diablo soils make up 45 percent of the association, and Altamont soils 45 percent. Linne and Olivenhain soils make up the remaining 10 percent.

Diablo soils are dark-gray clays. Altamont soils are dark-brown clays. These soils overlie light yellowish-brown or light-gray marine sandstone and shale that range from noncalcareous to strongly calcareous.

These soils are used mostly for truck crops, range, and housing developments. A few small areas are used for dryfarmed barley. The occasional light frosts cause very little damage to winter vegetables. Urban and industrial uses are increasing in the southwestern part of the county.

28. Diablo-Linne Association

Well-drained clays and clay loams; 15 to 50 percent slopes

This association is made up of soils that developed in material derived from soft calcareous marine sandstone and shale. It occurs on uplands on the Coastal Plains. The elevation ranges from 100 to 600 feet. The mean annual precipitation is between 12 and 14 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 280 to 340 days. The vegetation consists of annual grasses and forbs, flattop buckwheat, California sagebrush, sugarbush, and scrub oak.

This association occupies about 1 percent of the San Diego Area. Diablo soils make up about 50 percent of the association, and Linne soils about 40 percent. Salinas and Olivenhain soils make up most of the remaining 10 percent.

Diablo soils are dark-gray clays. Linne soils are gray clay loams. These soils overlie light-gray to white, calcareous shale and sandstone. In many places the surface layer is moderately to strongly calcareous.

These soils are used mostly for range. A few areas are used for dryfarmed grain and irrigated tomatoes. Urban development is increasing in areas southeast of the city of San Diego.

29. Diablo-Las Flores Association

Well drained clays and moderately well drained loamy fine sands that have a subsoil of sandy clay; 9 to 30 percent slopes

This association is made up of soils that developed in material derived from calcareous and noncalcareous marine sandstone and shale. It occurs on

30. Las Flores-Huerhuero Association, Eroded

Moderately well drained loamy fine sands to loams that have a subsoil of sandy clay or clay; 9 to 30 percent slopes

This association is made up of soils that developed in material derived from sandstone or marine sediments. It occurs on uplands on the Coastal Plains. The elevation ranges from sea level to about 500 feet. The mean annual precipitation is between 10 and 13 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 300 to 350 days. The vegetation consists of brush, forbs, and annual grasses.

This association occupies about 2 percent of the San Diego Area. Las Flores soils make up about 45 percent of the association, and Huerhuero soils about 40 percent. Diablo soils, Linne soils, Olivenhain soils, and Terrace escarpments make up the remaining 15 percent.

Las Flores soils have a surface layer of light brownish-gray loamy fine sand and a subsoil of grayish-brown sandy clay. Huerhuero soils have a surface layer of brown loam and a subsoil of brown clay. Las Flores soils overlie soft sandstone and shaly marine sediments, and Huerhuero soils, yellowish-brown loamy sand.

These soils are used mostly for range. A limited acreage is used for irrigated truck crops. Urban and industrial uses are increasing.

31. Gaviota-Hambright Association, Eroded

Well-drained fine sandy loams and gravelly clay loams over sandstone and breccia; 30 to 75 percent slopes

This association is made up of soils that devel-

Group VIII. Miscellaneous Land Types of the Desert, Mountains, Foothills, and Coastal Plains

The miscellaneous land types in this group vary

They are used only for wildlife habitat, watershed, and recreational areas.

Three associations in the San Diego Area are in this group. They represent about 12 percent of the Area.

32. Rough Broken Land-Terrace Escarpments-Sloping Gullied Land Association

Steep and very steep dissected land, escarpments, and gullied land

This association is made up of areas that are of no value for farming and ranching. It occurs in the Desert, in the Mountains, in the Foothills, and on the Coastal Plains. Some of these areas are almost barren; some have a moderate cover of chaparral

the gullies are eroding into the soft sandstone, shale, and decomposed granite.

These miscellaneous land types are used mainly for watershed.

33. Badland Association

Dominantly barren eroded shales

This association is made up of moderately sloping to steep, essentially barren areas that are dissected by few to numerous intermittent drainageways. It occurs in the Desert. It is underlain by shale, soft sandstone, and silty, sandy, and gravelly sediments. Runoff is very rapid, and erosion is very active. Sediment yield is very high.

This association occupies less than 1 percent of the San Diego Area.

Badland makes up about 65 percent of this association. Acid igneous rock land, Rough broken land, and sand dunes make up the remaining 35 percent.

Badland is of no value for farming or ranching

Formation of the Soils

The parent material from which the soils in the survey area developed is complex and variable.

The relief differs among the four physiographic provinces--the Coastal Plains, the Foothills, the

terraces ranges from nearly sea level to about 800 feet.

The Coastal Plains has the most equable climate of any area in the county. Temperature and precipitation vary according to the elevation and the distance from the seacoast. Generally, the temperature decreases and the precipitation increases with increasing elevation. The mean annual temperature is 61° F., and the mean minimum temperature in January is 42°. The frost-free season is 280 to 360 days

Diablo, Linne, and Altamont soils are fine textured to moderately fine textured. Huerhuero, Las Flores, and Stockpen soils have an argillic horizon. Gaviota

Foothills

The Foothills is a belt of ...

disintegrated boulder (2). Associated with this bouldery topography are the rocky Cieneba, Fallbrook, and Vista soils. All have large boulders on the surface and within the gruss, which is weathered to a considerable depth.

Parent material weathered from decomposed granite

fragments. Auld and San Miguel soils were derived from metavolcanic rock and contain montmorillinitic clay. Escondido, Exchequer, and Friant soils were derived from metasedimentary rock and are fine sandy loam to silt loam in texture. Exchequer and Friant soils lose soil material through erosion al-

Desert. This material is soft and is easily eroded. It contains sand fragments, mainly quartz, that act as an abrasive when carried by runoff. The soils derived from decomposed granite are shallow to deep and are mostly sandy loams. The topography is hilly. Hilltops are rounded or slightly convex, slopes are moderate to very steep, and foot slopes are somewhat concave. Cultivated areas are subject to gully and sheet erosion. The Bonsall, Bosanko, Cieneba, Fallbrook, and Vista soils in the Foothills were derived from decomposed granite.

Gabbro, or basic intrusive rock, occurs as islands in the Foothills and in the Mountains. It has weathered to a considerable depth. The soils that developed in this material have a surface layer of fine sandy loam or loam, are shallow to moderately deep, and contain angular, stone size fragments. There are no boulders in these areas, in contrast with the very large, light-colored boulders strewn about in areas underlain by granite. The topography is hilly. Some slopes are steep and have concave foot slopes. Cultivated areas are subject to sheet and gully erosion. The Las Posas and Blasingame soils in the Foothills were derived from gabbro.

Metasedimentary and metavolcanic rocks, which oc-

The young granitic alluvium in the Foothills was derived predominantly from granitic rock. It is very gravelly sandy loam to fine sandy loam in texture and is fairly well sorted. It occurs in broad basins, on alluvial fans, and in narrow drainageways. The Anderson, Chino, Grangeville, Reiff, and Visalia soils in the Foothills developed in this material.

The old granitic alluvium that has formed in valleys and on terraces and alluvial fans in the Foothills is mainly granitic in origin but has small inclusions of medium-textured sediments of Pleistocene age. Arlington, Greenfield, Placentia, Ramona, and Wyman soils in the Foothills developed in this alluvium. Except for Arlington and Greenfield soils, all have a strongly developed clayey subsoil.

Mountains

Between the Foothills and the Desert are steep-walled, bouldery peaks and broad-based, cone-shaped mountains (fig. 7). The topography is rugged. The elevation ranges mainly from 2,000 to 6,000 feet; some peaks rise above 6,000 feet. The mountain the greater part of this area unusable for cultivated crops.

The Mountain area is the coolest, wettest part of the San Diego Area. It receives 12 to 40 inches of precipitation, mainly in winter. The mean annual temperature is 55° F., and the mean minimum temperature in January is 32°. The frost-free season is 150 to 200 days. Snow stays on the ground for only short periods. The soils rarely, if ever, freeze.

Vegetation is more abundant in the Mountains than in other parts of the Area. It consists of digger pine, Jeffery pine, white fir, black oak, interior live oak, and incense-cedar. There are also areas of grass and brush. Soils under the pine and oak trees have mats 1 inch to 5 inches thick of fresh and somewhat decomposed needles, leaves, and twigs. The cool climate slows the rate at which microorganisms reduce the supply of organic matter, so these soils typically have the highest organic-carbon content of any soils in the survey area. The organic-carbon content is about 4 percent in the surface layer. It drops to less than 1 percent in the subsoil. Most of the soils are leached of lime and soluble salts.

Granitic rocks, mainly granodiorite and quartz diorite, are dominant in this area (3). Bancas, Crouch, Kitchen Creek, La Posta, and Tollhouse soils

surface layer of loam and contain many angular, stone-size fragments. There are no boulders.

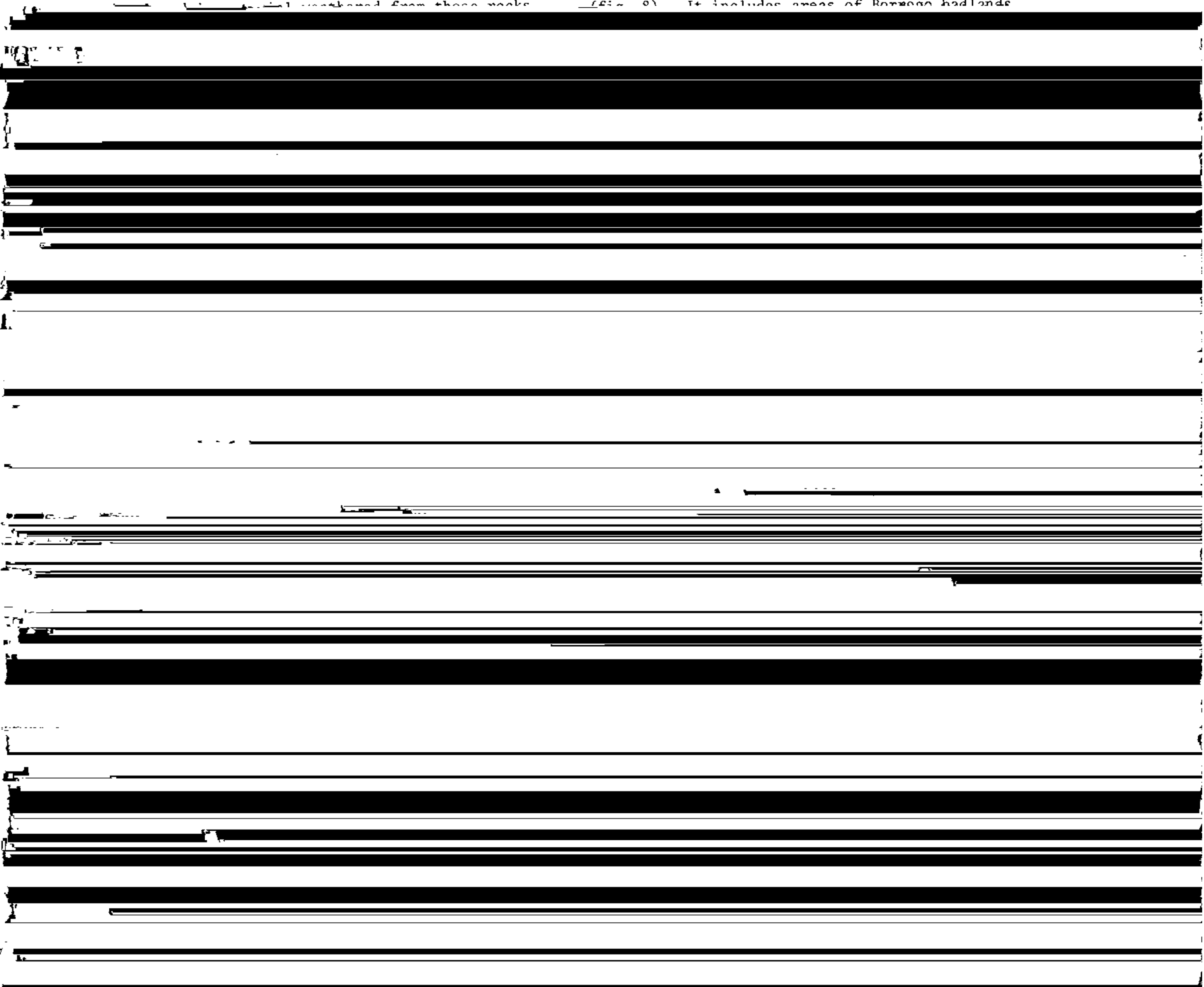
Micaceous schist, which is strongly metamorphosed, occurs as bands tilted nearly vertically. Holland and Sheephead soils were derived from this material. Both are steep to very steep and have a surface layer of fine sandy loam. Holland soils are deep and have a clay subsoil. Sheephead soils are shallow.

Young granitic alluvium was derived predominantly from granitic rocks. It is loamy coarse sand to coarse sandy loam in texture and is fairly well sorted. It occurs on alluvial fans and in narrow drainageways. The Mottsville soils in the Mountains were derived from this material. Calpine soils were derived from slightly older granitic alluvium.

Arkose, which is a form of old granitic alluvium, is sandy loam in texture. It occurs in broad basins in the Mountains. Bull Trail soils were derived from this material.

Desert

The Desert, which lies in the rain shadow to the east of the Mountains, is an area of recent, nearly level to moderately sloping alluvial fans and plains



The Desert has a wide range of seasonal and daily temperatures. The mean annual temperature is 72° F., and the mean minimum temperature in January is 36°. The high temperature increases the rate of oxidation, so the organic-carbon content of the soils is very low. The frost-free season is 240 to 270 days. Soils in the Desert show little soil development because of lack of moisture. They tend to be alkaline, because most of the moisture evaporates and leaves dissolved salts.

Granitic rocks in this area occur as barren hills of rock outcrops or large, light-colored granitic boulders that have very little soil material between them. These hills are mapped as Acid igneous rock land.

Young granitic alluvium was derived predominantly from granitic rocks. It is very gravelly sand to loamy coarse sand in texture and is fairly well sorted. It occurs in broad basins, on alluvial fans, and in narrow drainageways. Some of this material washes down the steep slopes of the Mountains; the rest is from the granitic rock in the Desert. The Carrizo and Rositas soils in the Desert developed in young granitic alluvium.

Recent mixed alluvium was derived from igneous rocks and micaceous schist. It has been deposited on alluvial fans. This material is finer textured than young granitic alluvium and has been deposited more slowly. It ranges in texture from coarse sandy loam to silt loam. Indio and Mecca soils were derived from recent mixed alluvium.

The shales, sandstones, and conglomerates in the Desert form essentially barren areas that are cut by numerous intermittent drainage channels. These areas are mapped as Badland.

The essentially barren, flat areas of lacustrine deposits are Playas. These deposits are clayey or silty in texture and are typically moderately to strongly saline. Playas form in closed basins in the Desert. Some contain shallow water for a short period after a rain.

Agriculture is one of the major enterprises in the San Diego Area (5). Truck crops, flowers, and livestock are the major products. Prime soils 5/ are required to maintain the agricultural economy at its present level. However, demands for urban or nonfarm use of the soils, rising land values, and increasing taxes make it increasingly difficult for the farmer to stay in business. Intensive farming practices, specialized production, and high capital requirements have changed many agricultural units from the small family-size farm to a factorylike operation. In addition, the rapid expansion of urban develop-

Land Resource Area 19.--This area includes the Coastal Plains and the interior valleys in the Foothills. The dominant topographic features are gently sloping to undulating marine terraces, rolling uplands, smooth to rocky hills, canyons, and relatively narrow, winding valleys. All rivers and streams flow into the Pacific Ocean. The vegetation consists of coastal chaparral and grasses. Oaks grow in the valleys. Elevations range from sea level to 2,000 feet. Rainfall ranges from 10 inches along the coast to 18 inches inland. The only precipitation is gentle rain in winter and early extends from Riverside County to the Mexican border. It is characterized by many short ranges of nearly barren mountains, some older alluvial deposits or

terrace remnants, and extensive recent alluvial fans and desert basins, some of which are saline or saline-alkali. Elevations range from 100 to 2,500 feet. The mean annual precipitation is less than 5 inches. Much of the precipitation falls during high intensity storms, which at times produce local floods and little soil moisture. The climate is extremely arid. The vegetation is sparse desert shrubs and cactus. Some areas have a fair cover of mesquite and creosotebush. Temperatures are high in summer, and there is a wide fluctuation between the maximum and the minimum temperatures.

The major limiting factors are lack of irrigation

however, measures are needed for reducing the flood hazard.

The choice of crops is somewhat limited because

of the climate. Forage crops are the principal crops, but citrus, grapes, cotton, and vegetables are grown also.

Crop Suitability

The western third of the San Diego Area, that is, the Coastal Plains and the Foothills, Land Resource Area 19, is climatically adapted to year-round agricultural production. Elevations are near sea level to about 2,000 feet. Avocados, citrus, truck crops, tomatoes, and flowers are the major crops.

Except for the alluvial plains, the soils on Camp

NATIONAL COOPERATIVE SOIL SURVEY

Western Regional Conference Proceedings

Phoenix, Arizona
February 9-13, 1976

Proceedings of ...

WESTERN REGIONAL TECHNICAL

WORK-PLANNING'CONFERENCE

OF THE

COOPERATIVE SOIL SURVEY

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WESTERN TECHNICAL WORK PLANNING CONFERENCE

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Western Technical Work Planning Conference
of the
National Cooperative Soil Survey

Phoenix, Arizona
February 9-13, 1976

Conference Agenda

Monday, February 9 - Cactus Room

Chairman - C. Guernsey

8:00-9:00 Registration

9:00-9:15 Announcements and Introductions

9:15-9:30 Welcome to Arizona - T. G. Rockenbaugh, State Conservationist, SCS, Arizona

9:30-9:45 An Overview of the Natural Resources of Arizona - G. R. Stairs. Dean, College of Agriculture, University of Arizona

9:45-10:00 Recess

10:00-10:30 Operations Management in the Soil Survey Program, K. L Williams, Director. West Technical Service Center, SCS

10:30-11:30 The National Soil Survey Program - W. M. Johnson, Deputy Administrator for Soil Surveys, SCS

11:30-12:00 Discussion Period

12:00-1:00 Lunch

1:00-3:40 Discussion Groups - Walnut, wisteria and Magnolia Rooms

3:40-4:00 Recess

4:00-5:20 Discussion Groups Continue

Tuesday, February 10

8:00-10:40 Discussion Groups - Walnut, Wisteria and Magnolia Rooms

10:40-11:00 Recess

11:00-12:20 Discussion Groups Continue

12:20-1:30 Lunch

1:30-2:50 Discussion Groups Continue

2:50-3:10 Recess

3:10-4:30 Discussion Groups Continue

4:30-5:00 Committee Chairmen meet with Recorders

Wednesday, February 11 - Cactus Room

Chairman - T. Hutchings

8:00-8:30 Status of Soil Surveys in the West - J. M. Williams

8:30-8:45 Developments in the Bureau of Reclamation - W. B. Peters

8:45-9:30 Committee Meetings

9:30-5:00 Field Trip - Tour Leaders - D. Hendricks, J. Jay, M. Openshaw, D. Richmond and C. Williams

Participants will leave the morel at 10:00 a.m. and travel by bus to the Salt River Project. Here we will Set the story of the collection. storage and distribution of water for use in the "alley of the Sun. Lunch in the SRP cafeteria. Enroute to

Thursday - February 12 - Cactus Room

Enmute

Friday - February 13 - Cactus Room

Chairman - D. Hendricks

8:00-9:00 Committee 6 Report - Soils and Soil Materials Distributed by Mining Operations - A. R. Southard

9:00-10:00 Committee 7 Report - Soil Survey Interpretations - Tommie Holder

10:00-10:15 Recess

10:15-11:15 Committee 8 Report - Soil Surveys far Woodland, Rangeland and Wildlife - F. F. Peterson

11:15-12:00 Business Meeting

Committee Assignments
Western Work Planning Conference
For The Cooperative Soil Survey
1976

Phoenix, Arizona

Committee 1 - Modernizing Soil

Dick Kover, Chairman

Committee 2 - Improving Soil Survey Techniques

Committee 3 - Waste Disposal on Land

W. D. Nettleton, Chairman

R. D. Heil
H. Ikawa
D. M. Hendricks
J. Nishimura
D. Jones
J. Allen
O. F. Bailey
E. M. Richlen
T. B. Hutchings
G. Otte
E. A. Naphan
J. Jay
M. Openshaw

Charge 1. Assess the adequacy of soil properties selected as guide criteria by ratings select bench mark soils. Indicate the kind of waste disposal for which the soil is being rated.

Charge 2. Recommend addition, deletion or change of criteria, if needed.

Charge 3. Prepare a list of the different kinds of wastes and determine need for the development of guidelines for specific kinds of waste.

Charge 4. Assess experimental work now underway in region and prepare summary for Conference. (CRS computer file may help.)

Charge 5. Develop guidelines for rating organic soils in the treatment of municipal waste water.

Committee 4 - Water Relations in Soil

J. R. Talbot, Chairman

H. Ikawa
O. R. Harju
L. Daugherty
R. Gilkerson
E. Brown
G. A. Nielson
T. B. Hutchings
D. Gallup
T. Collins

Assess application of hydrological models used by ARS and EPA pertaining to agriculture, land.

Charge 1. List soil and landscape properties required for these models. Indicate those not available from order 2 or 3 soil surveys.

Charge 2. How can properties needed but not now available be obtained.

Examine the application of ARS hydrological model USDAHL-74 and EPA Agricultural Chemical Transport Model (ACTMO) in the soil survey.

Charge 3. Can soil moisture patterns bc predicted more accurately by use of one of these models.

Charge 4. Should application of HL-74 be considered for application in taxonomic soil moisture eegimes.

Charge 5. Assess application of HL-74 in the region to predict change of streamflow and overland flow resulting from change in land use on a watershed.

Charge 6. Review definitions end criteria related to soil-rater relations in the draft of the Soil Survey Manual.

Committee 5. General Soil Maps (Publication Area)

Don Stelling, Chairman

R. F. Mitchel
S. Rieger
J. Rogers
R. Kronenberger
R. D. Heil
G. H. Simonson
H. Havens
D. Kover
J. Owen Carleton
J. Hagihara
John Douglass
Arnold O. Ness

Charge 1. Assess where general soil maps of soil survey area can best be published. Should it continue to be a par-t of the soil survey report.

Charge 2. Recommend scale for general soil maps in a published soil survey - 1:100,000 has been suggested.

Charge 3. Develop models of mapping units with special attention given to discussing general land use and potentials.

Committee 6 - Soils and Soil Materials Disturbed by Mining Operations

A. R. Southard, Chairman

3. Rogers
T. Holder
E. Brown
L. Leifer
G. A. Nielsen
L. Daugherty
E. Naphan
K. Karsen
J. cl. Carleton
H. Havens
J. Stroehlein

Charge 1. Classification of Soils on Mine Spoils

a. React to the proposal in the 1975 National Soil Survey Conference Report that a suborder of spolents be established for highly disturbed soils. (Report of the Committee on

b. Assess the feasibility of setting a limit between Orthents (or Spolents) and Arents at 20 percent by volume of fragments of diagnostic horizons in the 10 to 40 inch section. Would other limits be better?

c. Develop criteria for Fluvents and Fluventic subgroups that would exclude soils in mine spoils that have an irregular distribution of organic carbon with depth.

Charge 2. Develop criteria for interpreting soils for the optional use and treatment of land affected by mining operations.

a. Develop guide for rating soil material for use as final cover for mined land.

b. Results of investigations of special problems encountered in soils on mine spoils should be assembled for guidance in making interpretations.

c. A number of the cooperators in the NCSS are presently involved in making guide lines for reclamation of mine spoils. There appears to be little or no coordination among the agencies. Assemble a summary of available guidelines in a form that may be used as a guide for developing general standards for all cooperators.

Committee 7 - Soil Survey Interpretations

T. Holder, Chairman

G. Kennedy
F. F. Peterson
D. Pease
L. Langan
D. Huff
O. Bailey
D. Jones
P. C. Singleton
O. R. Harju
J. Douglass
M. Openshaw

Charge 1. Prepare models of soil interpretations that can be made for order 3. 4, and 5 soil surveys. Develop criteria for interpretations.

Charge 2. Expand concept of soil potential

a. Develop list of kinds of soil potential needed.

b. Develop example 'of how to show the "imporvement needed" to achieve potential. Give special attention to things that should be included and those that should be excluded.

c. Prepare models of map units descriptions of various orders showing how to incorporate the "potential" concept.

Charge 3. Prepare interpretation guides for organic soils using as an example the guides prepared in the northcentral and northeastern states. (The northeastern and northcentral guides are found in the 1975 National Soil Survey Conference Report).

Charge 4. Evaluate procedure now used for obtaining crop yield potential. Is the present system adequate or should a more precise procedure be used.

Committee 8 - Soil Surveys for Woodland, Rangeland and Wildlife

F. F. Peterson

G. Otte
M. Fosberg
R. T. Meurisse
G. Kennedy
B. Seay
T. Collins
V. Hugie
R. Parsons
D. Richmond
J. Allen
H. Havens
A. Southard
J. Stroehlein

Charge 1. Identify means of making useful interpretations of multitaxa soil mapping units.

Charge 2. Prepare ways of using MP techniques to analyze soil surveys for use in resource planning.

Charge 3. Study relationship between interpretive groupings such as range sites, woodland sites and ecological sites and mapping units.

Charge 4. Identify the requirement needed in designing a mapping unit to be interpreted for range sites, woodland sites, ecological sites, etc. Develop a model that can be used for all.

WESTERN TECHNICAL WORK PLANNING CONFERENCE

of the

NATIONAL COOPERATIVE SOIL. SURVEY

Minutes of Annual Business Meeting
February 13, 1976
Ramada I”“, East
Phoenix, Arizona

The meeting was chaired by J. M. Williams, Principal Soil Correlator, Portland, Oregon.

The motion was made and passed that San Diego be selected as the semi-permanent meeting place for the conference, beginning in 1978, with Alaska as the host state. In a separate motion, unanimously passed, R. T. Meurisse was selected as cochairman of the 1978 conference LO serve with Samuel Rieger.

The following resolution was proposed by Fred Peterson and passed unanimously:

> "It is the sense of the conference that committee chairmen cell at least one working meeting of his committee prior LO the conference.”

Carl Guernsey proposed the following resolution concerning the field trip on Wednesday. The resolution Passed unanimously:

> “Participants in the 1976 Western Soil Survey Conference extend their sincere appreciation to Ted Wilson of the Salt River Project and to Dr. Herman Bouwer of the ARS for their contribution to the success of the conference.”

Jack Rogers proposed the following resolution which was passed by majority vote:

WHEREAS -

the report of proceedings from the National Soil Survey Work Planning Conference does not always address itself to Regional Soil Survey Work Planning Conference Committee recommendations,

- be it resolved that the 1976 Western Soil Survey Work Planning Conference proposes that the National Soil Survey Work Planning Conference give acknowledgement in their committee reports to the recommendations submitted by each Regional Committee and, to the extent possible, address their comments and recommendations to these Regional Committee Reports.

NATIONAL COOPERATIVE SOIL SURVEY

I am pleased to participate in your work planning conference for the National Cooperative Soil Survey. It is rattler obvious from the number of you who are representing other Federal agencies and tile agriculture experiment stations that this is truly 8 cooperative venture. If my information is correct this is the first meeting of this type in the west to be attended by the TSC Director and State Conservationists other than that of the host state. Unfortunately not all of the State Conservationists could attend because of prior schedules. I am extremely pleased to find this blend of line and staff assembled here to work toward a common goal of finding ways to accelerate soil surveys and at the same time improve the quality of maps end interpretations insuring the users of a quality product.

The demand for soil surveys is greater at this time than at any other period in history and can be expected to increase. The need for soil. surveys has bee” brought into sharp focus by the intense concern for lend “se planning. We need to strengthen all our efforts because of the need to increase the production and usefulness of soil surveys. They must be available to meet growing and changing demands from national. state and local levels of government as well as individuals. It is imperative that the soil information be provided in a timely manner. This will require the full cooperative effort of all agencies present here today, fully utilizing all disciplines to make the soil survey program move ahead. We need to function in a way that will provide reliable soil resource data in an understandable farm to more of the people that can benefit from the data.

Soil survey operation has experienced many significant changes since your last conference in San Diego two years ago. Many of the changes are a direct result of procedures specifically designed to accelerate the publication of soil surveys. These changes will directly influence the work of all SCS people at this meeting and most of our cooperators.

Far many years field mapping was completed on more soil survey areas than were published. This resulted in a backlog of unpublished soil surveys that contained valuable information urgently needed by the users of sails data. Also there existed a

The successful implementation of the plan to accelerate soil survey publication is dependent on close adherence to sound management principles. Jobs must be completed on schedule. Also the schedule must be realistic in the timing of all activities that will result in publication one year after the completion of field work. We have basic guidelines now to direct such a plan. Many of the activities must be scheduled before the soil survey is started. And all must be scheduled well ahead of the last day of the field mapping.

The changes in cartographic procedures involves principally the elimination of map finishing and related editing activities. Suitable base maps and overlays with roads, and other cultural features pre-drafted by cartographic must be available before field mapping or map compilation. This calls for careful scheduling well in advance of the start of field work. The availability of photography has been a problem to date. I am sure Bill Johnson will cover this in depth so I will only add that the procurement of base maps and overlays must be carefully scheduled.

Much of the text manuscript preparation has been automated. Nodular writing is being used where possible. Press-ready tables of soil interpretations will be printed from data stored in the Statistical Laboratory in Ames, Iowa. Tables of soil interpretations, however, cannot be printed unless the basic input of SCS-Soils-S's is made several months in advance of the date of need. I strongly urge that tables of soil interpretations for the named series shown in the legend be obtained early in the survey so the interpretations can be made part of the technical guide and tested before being published. We must supply the users of soils data with the most reliable data that we can. This is ""e important way to do it. I" some instances, states are still waiting until the last possible time to request the tables of interpretation. This must be corrected immediately.

We are still receiving many soil interpretation records -- the SCS-Soils-5 form -- that are incomplete or with errors. It is extremely expensive in both money and time resources to make the needed corrections. In a number of cases it is rather apparent that the soil scientist is still completing the SCS-5 form alone and other interested disciplines have no input. This lack of interdisciplinary involvement contributes to the inadequate interpretations. All interested disciplines must share a responsibility in preparing the interpretation form. We choose to believe that this is not the result of the soil scientist ignoring the other disciplines but the failure of individual APO's to provide this assistance. The state conservationist and area conservationist will need to see that better scheduling is used that will correct this problem.

This clearly signals the need for more effective planning in soil survey operations. A detailed project control system must be developed for each project soil survey. The plan must show a schedule for each activity, milestone events that must be met co stay on schedule and who (discipline) will have an input into each activity. A schedule that shows the job and who will have an input is a vital tool to be used when preparing individual APO's.

I am happy to state that Arizona has moved out on this and has project control systems developed for several project soil surveys. The signal that I received indicates these systems are well worth the time used in developing them.

I strongly urge that each of you develop a PCS for all project soil surveys in your state.

It is Service policy to conduct research and short term field investigations to improve soil survey interpretations and classification. The Primary objectives of this work are to improve the reliability of soil survey interpretations. This requires close coordination of activities and exchange of information between the soil scientist engaged mainly in soil survey operations and the soil scientist and geologist engaged mainly in soil survey investigations. In the past this exchange has not bee" available in many areas.

To develop better lines of communication between investigations and operations the soil-geomorphology teams have been reorganized in order to give closer assistance to the field. One of the teams in the South is being phased out and reassigned to the WTSC to work in areas in the West with special emphasis on the Fort Union coal-deposit areas. In the Fort Union coal area, soil survey facts are badly needed to insure that large-scale land-disturbance plans are blended with proper programs to minimize environmental damages and enhance suitable land uses.

A team of Soil Survey Investigations Specialists, Dr. John W. Hawley, Geologist, former head of the Desert Project, New Mexico and Dr. Roger Parsons, Soil Scientist, former head of the Oregon project, have been added to the Soil Correlation Unit in the WTSC. This soil survey investigations team will provide direct technical assistance to ongoing soil surveys.

The work of this team "ill emphasize increasing the efficiency and accuracy of ongoing sail surveys reacting to technical needs recognized at district, area, and state levels. The initial phases of this work "ill stress short term field evaluations of basic relationships between soils, landforms and surficial geologic units in areas where soil surveys are being initiated or are in early stages. An important team function "ill be on-the-job training of field personnel in determining basic relationships between soil-map, taxonomic and geomorphic units where this will help increase the accuracy and efficiency of surveys.

As work progresses, needs for more detailed soil survey investigations projects will be recognized to solve specific problems in soil classification, soil correlation, mapping or interpretations. Such projects may emphasize the solution of specific applied problems or the understanding of processes of soil formation or principles of soil-geomorphology relationships that may be applied to the solution of local problems. Hopefully if the ty will f

In years past, the tables in a published soil survey have told a land user about his soils mainly in terms of "limitations". Little effort was made to inform the land user that many soils, even though rated with "severe limitation", can be made safe for use if the land user is willing to spend money to modify the soil, plan special designs, or adjust his way of operating. To merely tell a land user that he had a problem was not enough. He wanted to know what he could do about the problem. Consequently we received loud and clear signals from planners of all levels that a new direction is needed with our soil interpretations. It was stressed that we need to adopt a more positive approach for presenting soil behavior that will provide alternatives to the land user in both management systems and selected land "se. During the past few months there has bee" a" increasing encouragement from the Department and others for the SCS and other agencies to assume a strong roll in advocating sound land use decisions, in addition to our more traditional role of merely presenting the facts and alternatives. The SCS state conservationist's at their meeting a year ago recommended that such land use decisions be based on soil potentials developed through a" interdisciplinary approach using soil surveys and other natural resource data.

We have a loud and clear mandate to extend our soil interpretations beyond the identification of the kind and degree of soil limitations. To determine soil potentials we will need to consider practices that can be used to overcome limitations, what they cost and the local feasibility. Our "prime" land for different uses is not unlimited. At times we need to know how to use soils with moderate or severe limitations. This is important.

In future surveys, the SCS will emphasize a more positive approach called "soil potentials". We are going to give the land user more information about soil behavior so that he can better plan and evaluate alternative uses of his soil. New surveys "ill still warn of "limitations". but they also will describe ways to correct those limitations.

Soil potential ratings present a comparison of land-use alternatives in simple quantitative terms. The most suitable soils, e.g., sails with limitations easiest to overcome, will rate higher than soils with complex interacting limitations that are difficult to correct. When completed, the system looks simple, sounds simple, but the process of rating is complex. It involves physical and economic considerations. The effects of interactions among factors must be considered. To be successful the rating system requires a multi-discipline approach.

IL is now planned to hold a series of meetings this coming fall to train state and TSC technicians in the use of soil potentials. This will involve all disciplines. A committee under the leadership of Durwood Ball, Resource Conservationist. will organize the workshops and provide the training.

We are presently in the process of updating and revising the Soil Survey Manual. The purpose of the Soil Survey Manual is to provide the fundamental principles and concepts for making, interpreting. publishing and using soil surveys. It is the basic reference for the principles and concepts on which the National Cooperative Soil Survey is based. During the revision review copies have bee" provided to SCS scientists and cooperators and many useful suggestions have bee" received.

The Fifth Draft of the Revised Soil Survey Manual has now bee" circulated for review and testing to all states. Eighteen states were selected by the Principal Soil Correlators and Washington Staff to give special attention to the testing of technical standards to assure a cross section of opinion and experience representing the Land Resource Regions of the United States. A copy was to be provided to agencies that cooperate in the sail survey in your state. States selected in the west were: Alaska
California
Hawaii
Montana
Oregon
Utah

Review drafts prepared by you will be carefully evaluated by the Washington office soil survey staff and used in preparing the final draft of the Revised Manual. The tentative plan is to have the final draft ready for editing by November 1976 and publication by June 1977.

The responses to date have been very disappointing nationwide and the West is no exception. Responses have bee" very brief and incomplete. It appears that an indepth review of testing has not been made. Perhaps that time frame was too brief. Whatever, it is extremely important that you make an intensive review and testing of the technical standards. We need to generate the very best product possible to provide guiding principles for making a soil survey. This can be accomplished only by the input and cooperation of all agencies here.

As we Sear our programs for the increasing needs of a public that have recognized the need for soil information in making intelligent decisions about land use and management, we turn our attention to more efficient and effective methods for providing complex soil information. It is through meetings like this that we will sharpen up our delivery capabilities. The effort will require a blend of agencies and disciplines. One agency or one discipline will not accomplish it alone. Your cooperation, your dedication and enthusiasm will be vital.

Since the soil survey program is billed as the National Cooperative Soil Survey and my remarks thus far have related strongly to the Soil Conservation Service and its role as lead agency for the program, I think it's important that we think for a few minutes about our mutual interests and cooperation. We have talked a good deal about other users of soil survey information. However, I am aware that many new uses and pressing needs for soil survey and interpretative information are receiving much higher priority attention with the cooperating agencies. One specific example is the Bureau of Land Management in the Department of Interior. The director has formally contacted us end requested discussion on how to proceed with acquiring soil surveys on a vast area of National Reserve Lands. This brings to us a relatively new set of problems and need for more specific discussion. We would like to respond to BLM's request and I am confident that we will do our best to respond. However, their needs are of such magnitude that to accept their priorities in total would upset our whole program and other high priority efforts in many states. Somehow, some way must be found to find a balance and provide an effective means of addressing this new and critical need in the BLM. The same is now or may be true in the near future with other agencies. This potential is particularly significant as we feel more and more the impact of the National Environmental Policy Act.

What this means is that we have to be open, honest and practical in our cooperation and coordination efforts. SCS is no different from the rest of you. We have more work than staff available. We have the same kinds of personnel ceiling, travel restraints, and financial limitations as all the other agencies. We have made some long-term commitments that were based on the farmer program level and activity. We have our own need for soils data for our resource planning programs. On the other hand, we have the largest staff of qualified, trained and experienced soil scientists to do the field mapping, prepare the manuscripts and assist in developing the needed interpretations. The BLM and others of you have every right and reason to expect cooperation from the SCS. My point is that again this is not a one way street. I think it is reasonable for us to expect agencies who have or can develop the staff capability to commit themselves to making the maximum contribution possible to the National Cooperative Soil Survey. Because of our relatively high numbers of soil scientists, we have, in one sense, been raided by other agencies as they have recognized the need for this discipline. Wc have no major objection t" this, but it is disconcerting when highly trained soil scientists are lured from our ranks and then given assignments in their new agency that contribute very little or in no way to the national cooperative effort. I think it is time to take an honest look at this and see what opportunities exist to realize greater progress.

Another aspect of this whole problem we must

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION ACTIVITIES 1/

William B. Peters 2/

Soil Science and related activities of Reclamation programs primarily relate to water and land resource development. They include multipurpose land classification in determining land use suitability for multiobjective planning; economic land classification, wetland surveys, and drainage and reclamation of salt-affected lands on existing irrigation projects; soil characterization for irrigation scheduling; revegetation of lands disturbed through construction of project features; reclamation of lands to be surface mined of mineral deposits; soil inventory in areas potentially affected by development of mineral resources; land and water appraisals for environmental studies; remote sensing research; predicting quality of return waterflows into drainage systems; water quality control, particularly salinity of major river systems; soil investigation for other agencies; assistance in selection of lands for irrigation to foreign countries and international financing organizations; and participation in interagency affairs, on committees, at workshops, and professional societies. A portion of the lands surveyed for salinity and all the work on soil inventories and reclamation of lands to be disturbed by mining are performed for the USDI Bureau of Land Management through contractual arrangements.

It is Reclamation's practice to utilize USDA-SCS sail survey information to the fullest extent possible in all activities for planning, construction, development, settlement. operation and maintenence, and rehabilitation of projects. In this regard, Reclamation is very much interested in the new approach by the Soil Conservation Service to soil surveys, i.e., the concept and use of soil potential and related requirements in predicting and integrating land and management factors.

Preplanning for Lands to be Mined of Coal

The studies for BLM on reclamation of mineral areas are in response to the "coal rush" in meeting the energy crises. The objective is to identify optimum coal-leasing sites having superior potential for reclamation and to formulate lease stipulations. This involves obtaining basic data; making evaluations; and developing standards, guidelines, techniques, and alternate plans for land rehabilitation and restoring vegetative growth. The plans include recommendations for deposition and treatment of overburden and measures required to minimize environmental impacts, air and water pollution, and to promote safety. Environmental planning, design, and engineering are a very important aspect in formulation Where viable alternative opportunities for enhancement are identified, plans are developed as requested by BLM. Alternative land uses and potentials might include rainfed agriculture differing from present cover and enterprises, irrigated agriculture, wildlife habitat, recreation, homesites, industrial developments, and others. In this planning, analysis is made of land use problems and opportunities associated with water plans, recognizing the natural and a modified land base, existing and potential land use patterns, zoning regulations, and general relationships to environmental, social, and economic aspects of the setting. All plans developed include an assessment of cost and benefits.

The work is approached on an interagency and interdisciplinary basis. Reclamation, in cooperation with the USDI Geological Survey. is exploring and characterizing overburden 3/, surface and ground water, and developing and analyzing data with respect to geology, engineering, plant science, hydrology, soils, drainage, economics, ecology, environment, and other relevant considerations. The investigation with respect to lands largely involves characterizing the overburden for reclamation potential and determining land use suitability. In

1/ Brief report prepared for the Western Conference of The National Cooperative Soil Survey sponsored by the U.S. Department of Agriculture, Soil Conservation Service, Phoenix, Arizona, February B-13, 1976.
2/ Head, Land Utilization Section, Resource Analysis Branch, Division of Planning Coordination, Engineering and Research Center, U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.
3/ Overburden is the materiel consolidated or unconsolidated overlying the coal.

characterizing overburden, sufficient exploration and drilling are accomplished to describe and collect representative samples of soil and substrata to a depth below overburden and coal (maximum depth of 200 feet). The description of soil and substrata characteristics in relation to land characterization essentially conforms to the USDA National Cooperative Soil Survey procedures. Sampling of overburden at master sites and agronomic laboratory testing are on a comprehensive basis. At the other explorations and borings, representative samples are selected for laboratory characterization on a screenable basis to confirm judgment in

The results of these program efforts will be applied in the design of new projects and the rehabilitation of irrigation systems. The establishment of the Irrigation Management Services Program on irrigation and water districts is a cooperative effort with the Soil Conservation Service and the State Extension Service.

Colorado River Water Quality Improvement Program

The purpose of this investigation is to develop plans for controlling salinity in the lower

The Institute, as conducted in 1975. emphasized the physical factors inherent in the land use and water planning process. Such factors included soils, geology, geography, ecology, revegetation of stripmined areas, hydrology. archeology, anthropology. and others.

The Institute for 1976 will be emphasizing nonphysical factors involved in rhe planning process in realtion to the Principles end Standards. These include. but are not restricted to. economics, the legal aspects involved in water development projects. social implications, public involvement. a discussion of national policy toward water development, data acquisition and interpretation, demography, and the preservation of agricultural lands from a political viewpoint. The physics1 factors as presented at the 1975 Institute will again be generally reviewed as being required in the complete planning process.

Remote sensing Research

Reclamation continues to support research in remote sensing for many applications including land classification. Most of the Soil Science activities have been in cooperation with the EROS Program and directed toward development of methods to assist in better identification of depths to water table, surface water accumulation and drainageways, vegetative cover and crop identification, depth to root and water impeding barriers. end gross soil features including soil moisture end salinity.

This last year, our Research Division field treated a short-pulse radar system. This is being developed for (1) ground water depth measurement accuracy; (2) soil moisture content measurement; and (3) soil layering detection. This research was unsuccessful in attaining sufficient ground penetration.

Reclamation contracted with the Texas Agricultural Experiment Station, Texas A&M University, College Station, Texas, June 3, 1974, for remote sensing research of the Elephant Butte Reservoir, Fort Quitman Project, New Mexico-Texas (RGREP). The objectives of this program were twofold: (1) To investigate the utilization of remote sensing to assist in assembling resource and

Table I

IRRIGATION SUITABILITY LAND CLASSIFICATION

Fiscal Years 1976 end 1977

California

Mid-Valley, Raison City
Sacramento River Seepage Project

Colorado

Animas-La Plata Project
San Miguel Project

Idaho

Middle Snake River area
Salmon Falls Project
Upper Snake River area

Montana

Upper Missouri River Basin Project

New Mexico

Animas-La Plata Project

Oklahoma

Oklahoma State Water Plan - Phase II
Waurika project

Oregon

Rogue River Basin
Grant Pass Irrigation District
Warm Springs Indian Reservation
Silvies River Basin

Utah

Central Utah Project, Bonneville Unit

Washington

Yakima Indian Reservation
Spokane Indian Reservation
Columbia Basin Project
Yakima River Basin
Colville Indian Reservation

Table II

MULTIPURPOSE LAND USE SUITABILITY CLASSIFICATION
FOR MULTIOBJECTIVE PLANNING

Fiscal Years 1976 and 1977

California

Butte Valley Project
Lake-Yolo county
Mendocino County
Nampa County
New Melones Project
Solano county
Upper Klamath Basin
Ventura county

Idaho

Middle Snake River area
Minidoka Project
Upper Snake River area

North Dakota

App2 0 qeek Project

Oregon

Rogue River Project
Upper Klamath Basin
Williamette River Project

Washington

Yakima Project

Wyoming

Riverton Project

RESEARCH RELATED TO SOIL SURVEY
AT THE ARIZONA AGRICULTURAL. EXPERIMENT STATION

THE UNIVERSITY' OF ARIZONA

D. M. Hendricks

The research related both directly and indirectly with soil survey at the Arizona Experimental Station is grouped under the heading of "soil as a natural body." This is part of the sail resources research program in the Department of Soils, Water and Engineering. Our concern with soils as natural bodies includes considerations of their composition, properties, formation (genesis). processes presently taking place in them, their geographic (in situ) distributions and relationships, and their use potentialities. Two researchers are currently involved in research related to soils as natural bodies. D. M. Hendricks is mainly concerned with basic research, particularly w'th respect to soil micromorphology, soil mineralogy and geochemistry as it relates to weathering and soil formation. D. F. Post's research is more applied, especially with regard to lend use planning.

The following summarizes the recent end current research related to soils as natural bodies:

1. Clay minerals characterization of sails from the Basin and Range Province in Arizona.

The clay mineral composition of a number of roils from the Basin and Range Province in Arizona has been characterized by X-ray diffraction analysis. Many of the soils studied were collected on field reviews of the National Cooperative Soil Survey Program in the state. Others were collected in conjunction with the SCS Soil Laboratory Characterization sampling. On the basis of the accumulated date we are now able to make some generalizations about the nature and distribution of the clay minerals in the Basin and Range Province in Arizona.

2. Clay mineral characterization of soils formed in basaltic pyroclastic parent materials.

The clay mineral composition of a number of soils formed from basaltic cinders in Arizona and a few in California has been determined. These soils represent a fairly wide range of climatic regimes end in degree of morphological development. It was found that soils with limited development under a semiarid climate in Arizona (Torriorthentic Haploborolls aund

3. Soils of Wide Rock Butte, Canyon de Chelly National Monument, Arizona.

A soil-vegetation study on a" isolated mesa in Canyon de Chelly National Monument was recently completed. This study was made by a team of scientists (pedologist, botanist, ecologist, paleoecologist and archeologist) in cooperation with the National Park Service.

As a follow-up to this study, the soil samples are being further analyzed far the purpose of determining the origin of the clay minerals and the mode of formation of the argillic horizons that are present in the soils. It is also planned to extend the study further by determining the geochemistry (major element and possibly trace element) associated with soil formation on Wide Rock Butte.

4. Soils of Greens Peak, Apache County, Arizona.

Greens Peak, a cinder cone attaining a" elevation of about 10,000 ft., is covered with forest on the north aspects and grass on the south aspect. To determine how the soils differ, pedons have bee" sampled at given increments of aspect around the 9,700 foot contour. Currently pH, organic carbon, total nitrogen, cation exchange capacity, exchangeable bases (Ca, Mg, Na, K), bulk density, and particle size distributions are being determined. Our preliminary data indicate that the soils (both grassland and forest) might be classified as Typic Cryandepts.

This study may be extended to consider the nature and distribution of iron oxides, nature and distribution of the forms of phosphorus, and the nature of the clay minerals in the soils.

5. Soil and Nutrient Balance Studies in Ponderosa Pine Ecosystems, Beaver Creek Watershed.

These studies are in cooperation with Dr. J. O. Klemmedson of the Forest Hydrology group in the School of Renewable Natural Resources (U of A) and the Rocky Mountain Forest and Range Experiment

There are two projects dealing with soil interpretations. One is the 'Characterization, Classification, and Data Interpretation "f Hawaiian Soils", which is a cooperative project with the Soil Conservation Service. This particular project emphasizes, in particular, the build-up of the Hawaii soil data bank, the relationship bet,,"" soil properties and behavior, and the potential ratings of soils for specific uses. The other project relating to soil interpretations is "Soil Interpretations and Socio-Economic Criteria for Land Use Planning", which is part of the Western Regional Project W-125. The objectives of this project are (1) determination of physical and socio-economic causes and consequences of encroachment by urban activities upon rural lands. (2) identification and organization "f the kinds of soil behavior and soil-landscape data and interpretations needed by present and potential clientele, (3) evaluation of the adequacy of present basic and interpretive data being offered for land use planning, and development of additional, critically needed quantitative data. interpretations, and alternative procedures for overcoming soil limitations.

Another project related t" soil survey and classification is the "Benchmark Soils Project". The research hypothesis is that agricultural technology in tropical regions can be transferred; that is, (1) through proper use of the Soil Taxonomy, predictions can be made about soil behavior from soils on which research has been conducted or on which experience is available to soils for which experience is lacking, (2) the soil family provides a" Important link between soil classification and land capability groupings, and (3) soils in the same family require essentially the same management practices. The maximum production results obtained in one soil family can be used as production targets for all soils belonging to the same or similar soil families. The objectives of this project are (1) to determine scientifically the transferability of agro-production technology among tropical countries, (2) to assist tropical countries in assessing the potential of upland soils for intensive cropping and intensive soil management. and (3) to demonstrate the value of soil, and land classification in formulating agricultural development plans in selective areas.

In another project, soil erodibility, as measured by rain simulation, was studied for nine important sail series. The work is summarized in the Achievement Analysis Report of the Hawaii Agricultural Experiment Station for the Fiscal Year 1973-74. This work is reported further in Control of Water Pollution from Cropland, Volume I, A Manual for Guideline Development (1975, pp. 16-21) published by the Agricultural Research Service and the Office of Research and Development, Environmental Protection Agency.

NEW MEXICO STATE UNIVERSITY

AGRICULTURAL EXPERIMENT STATION ACTIVITIES

in the

NATIONAL COOPERATIVE SOIL SURVEY

LeRoy A. Daugherty

The New Mexico Agricultural Experiment Station, in cooperation with the Soil Conservation Service, has completed publication of "Sail Associations and Land Classification for Irrigation..." for 31 of the 32 New Mexico counties. This joint effort has also completed publication of "Soils of New Mexico", which is a 131 page publication and an accompanying soil association map at the scale of 1:1,000,000.

The following publications have been published as a result of New Mexico State University and Soil Conservation Service research:

Anderson, J. U., O. F. Bailey and Dhanpat Rai. 1975. Effects of parent material on genesis of Borolls and Boralfs in South-Central New Mexico mountains. Soil Sci. Soc. Am. Proc. 39:901-904.

Anderson, J. U., D. Silberman and Dhanpat Rai. 1975. Humus accumulation in a forested Haploboroll in South-Central New Mexico. Soil Sci. Soc. Am. Proc. 39:905-908.

Gile, Leland H. 1975. Causes of soil boundaries in an arid region: I. age and parent material. Soil Sci. Soc. Am. Proc. 39:316-323.

Gile, Leland H. 1975. Causes of soil boundaries in an arid region: II. dissection, moisture, and faunal activity. Soil Sci. Soc. Am. Proc. 39:324-330.

Most soil survey related projects have had slow progress due to the untimely death of Dr. James U. Anderson.

Projects which are active or proposed are as fallows:

1. Soil Interpretations and Socio-Economic Criteria far Land Use Planning.
2. Classification, characterization and genesis of New Mexico soils.
3. Predicting soil loss from forest watersheds.
4. Soil mapping of agricultural experiment stations.

UTAH AGRICULTURAL EXPERIMENT STATION ACTIVITIES

IN THE

NATIONAL COOPERATIVE SOIL SURVEY

A. R. Southard 1/

The Utah Agricultural Experiment Station (UAES) contributes to the Utah portion of the National Cooperative Soil Survey through Western Regional Project W-125-Soil Interpretations and Socio-Economic Criteria for Land "se Planning.

The state soil survey leader participates in field reviews, field correlations and sampling projects in Utah. In addition, the UAES contributes soil characterization and other laboratory support through the Soil Testing Laboratory at Logan. The laboratory support includes routine soil and water characterization, engineering rests and ocher soil, plant and water analysis needed.

Preparation of interpretive reports of various areas in Utah is also part of Project W-125. Examples of these are Soils of Utah, UAES Bulletin 492, 1975; Soils and Soils Interpretations for Washington Co., Utah in progress. UAES also provides Soil Survey assistance to various other units of Utah Stare University. Some examples follow:

DEPARTMENT	ACTIVITY
Forest Service	SEAM Project-ECOSYM Model
Agricultural Engineering	AG Technology Transfer Model
Utah State University Foundation	Soil Survey of Oil Shale Lands in Utah
Geology	Research in Soils and Geomorphic Surfaces Relationships
Range science	Short Courses for Land Managers

Considerable time is spent in extension activities which are mainly advising students and others in the design of experiments using soil survey information. Also in process is the preparation of T. V. modules for use in acquainting the public with soils, soil surveys and their uses.

1/ Soil Survey Leader, Soils and Meteorology Dept.. Utah State University, Logan, Utah 84321.

FOREST SERVICE ACTIVITIES

in the

NATIONAL COOPERATIVE SOIL SURVEY

E. M. Richlen
Northern Region
U. s. Forest Service

The Forest Service soils program began 20 years ago. I" 1966 we had only 80 soil scientiests. Today. we have approximately 190-200 soil scientists, involving 110 National Forests and nine Regional headquarters. These figures do not include soil scientists working as planners, resource assistants or Rangers. We still do not have enough soil scientists to meet our land management objectives and goals. Many of you have worked with the various Regions in the Western U. S. and are aware of our highly decentralized organizations.

To date we have completed about 24 million acres of soil surveys as part of the National Cooperative Soil Survey. These surveys have bee" correlated. All Regions have ongoing Cooperative Soil Surveys.

In addition to the Cooperative Soil Surveys. we have completed about 65 million acres of soil surveys involving some different survey procedure methods. In some Regions, these surveys are called Soil Resource Inventories which, depending on intensity. could be classified as a third or fourth order in the kinds of surveys. I" other Regions a "Land System Inventory" is used which is an integrated survey involving the taxonomies of soils, vegetation and geology. A soil resource inventory is part of the Land System Inventory. We get good inputs from other specialists, such as hydrologists, silviculturalists, geologists, engineers, etc., in designing mapping units and in interpretations. I" the Northern Region wc use Daubenmire habitat types as our vegetation input. Geomorphology is used as a tool in the mapping techniques. I" the Northern Region, where the soils are relatively young, geomorphic processes relate to the genesis of the landscapes. In other areas it is possible to use a parametric process and, to a lesser degree, a third process of strictly landforms may be used. For example, landscape architects use landforms in their land classification system.

A hierarchical system has been developed for the "Land System Inventory." Seven categories are used and described in a publication by Wertz and Arnold. They range from physiographic province to section to subsection, to landtype association to landtype to landtype phase to site or project investigation. I" this mapping system we are looking at natural land systems. For example, in 'he Northern Region of the U. S. Forest Service we are mapping at the landtype level wherein soils are classified to the family level and vegetation by habitat type.

Forest soil scientists provide the full range of expert soil consultation services to a multi-resource land management effort and conduct the necessary field work and coordinating activities. Our data collection is aimed at providing soil information in a manner that is commensurate with other data inputs for completing the comprehensive lend use planning on all National Forest lands within a narrow designated time frame.

We have mode great strides in implementing our interpretative date in both long-range and short-range planning endeavors. Our soil scientists are sough' out as members of planning teams or at the very leas' as ad hoc team members. We prefer to be ad hoc members; thus, we have more time to develop basic earth science date. We are integrating the earth science and related information into natural ecosystems for analyses and management. In the future, we expect more earth scientists to look at the natural land system or landscapes. The mapping units will be a function of soils, vegetation, landscapes, geology, etc., in contrast to the early days where mapping units focused heavily on soil factors alone for definition and explanation. To us a soil mapping unit is the vehicle for interpreting the survey and they are unique to each survey area. The vehicle for transferring information is the taxa, not thr mapping unit, thus our concern that the taxa need to be carrelated, not the mapping units which are unique to each survey area.

Our soil surveys and land system inventories are oriented to land use planning and provide information to the Resource Planning Act.

Using this as a brief background, we would like to review our relationship with the National Cooperative Soil Survey.

Bill Wertz of our Washington Office and V. C. Link of the SCS made a field review in September 1975 to New Mexico, R-3; California, R-5; and Washington, R-6. One of the purposes of the review was to coordinate the Soil Resource Inventory with the National Cooperative Soil Survey. I understand they are now preparing a report on their recommendations. I" a recent visit with Bill Wertz, he thought some of the recommendations would be along the following lines:

1. Develop more communication to better understanding of agencies, objectives, policies, and procedures.

2. Reexamine the long-range publication plans oi the National Cooperative Soil Survey 0" Forest Service areas.

3. Explore the possibility of developing soil survey cooperative work plans for Forest Service soil resource inventory end possibly the land system inventory.

4. Identify added workload for a desirable level of coordination including correlation.

5. Consider information exchange system for correlation procedures, publications, soil interpretation systems, etc.

6. Improve processing of SCS soil series descriptions.

7. Insure that the Forest Service has opportunity to review and contribute to changes in guidelines for the National Cooperative Soil Survey. This is sometimes very difficult due to our limited manpower.

The above items may not be in the right order of importance and I may have missed some salient points. We believe our Memorandum of Understanding between the Soil Conservation Service and the U.S. Forest Service is a very viable document to operate with and that any major differences we have are in our priorities and lend management needs.

BUREAU OF RECLAMATION ACTIVITIES
RELATING TO SOILS ENGINEERING

O. R. Harju 1/

It is a pleasure for me to participate in this Western Regional Work-Planning Conference and to represent the Bureau of Reclamation along with Bill Peters, also of the Denver Office.

I have been asked to discuss with you some of the recent Bureau of Reclamation activities, and since I am actively engaged I" soils engineering, I will discuss some of the activities pertaining to this field.

The Bureau of Reclamation is an engineering organization whose main function is to design and construct irrigation and related facilities in the 17 Western States. Soil science activities of Reclamation programs relate primarily to water and land resource development. It is the practice of the Bureau of Reclamation to utilize Soil conservation Service soil survey information to the maximum extent possible in project planning activities.

I have selected five areas of soils engineering which the Bureau of Reclamation is currently engaged in and which I hope will be of interest to you.

<u>Lime Stabilization</u>

The use of lime as a" additive to soil dates back to the

Slide 8 - Lime stabilized canal side slope after 1 year of operation shows no sign of erosion, heave, or slide failures. It is unknown at this time how lime-treated soils will behave with time when inundated and subjected to the velocities of canal operation.

Frost Action in Soils

Frost action in soils has caused problems on Bureau of Reclamation projects which are located in cold weather areas. A Bureau of Reclamation Frost Action Team was organized to investigate new and economical methods of preventing damage to hydraulic structures from frost heaving.

The team proposed a plan for instrumenting canal structures with thermocouples and frost gauges to determine the effect of insulation on frost action in soil foundations causing damage to canal structures and to measure soil temperatures and frost depths in insulated and uninsulated areas.

A drop structure on the Lost Wells lateral located on silty sand soil with a high water table near Riverton

Slide 11 - Covered insulation.

Slide 12 - Frost gauge installation.

We hope this investigation will provide meaningful data for use in future hydraulic structure design.

Prewetting of dry, low density foundation soils by ponding of sprinkling is being used by the Bureau of Reclamation to subside these soils prior to construction. Several miles of the San Luis Canal in the Central Valley of California were prewetted by ponding, resulting in 15-foot settlements in the more critical areas. Plans are to prewet about 50 miles of subsidable soils along the Westlands Water District pipelines also located in the Central Valley of California. Sprinkler irrigation is being used to prewet some critical areas along the Granite Reef Aqueduct in Arizona.

The next slide is of a settlement plot in California showing progressive settlement up to 15 feet maximum due to wetting alone.

Backfilling of the trench follows closely behind the excavation of the trench so that only a short section of the trench is open at any one time to improve stability.

The backfill material is a well-graded gravel, sand, silt mixture coated lightly with slurry before being placed in the trench. Initially, the backfill is placed by lowering the material to the bottom of the trench with a clamshell bucket until the surface of the backfill rises above the slurry level and until a slope of angle of repose has been formed from the bottom of the trench to the surface. This operation prevents segregation of the backfill material. The remaining backfill material is pushed into the trench in a manner that will cause the material to slide progressively down the slope of the previously placed backfill material.

I have a few slides of the Wintering Dam slurry trench construction.

Slide 14 - Slurry pond. Mixing takes place in white shed and is pumped into pond. From pond it is pumped into trench as required.

Slide 15 - Looking west along cutoff trench at an overall view of slurry trench op- [redacted]

Slide 17 - Dozer mixing slurry with backfill material. A small amount of slurry is mixed with well-graded backfill, then pushed into trench.

Slope Stabilization

Slope stability or rather instability has long been a problem on Bureau of Reclamation projects. Failure of natural or excavated slopes usually occurs in areas of high ground water. Water seeping into soil behind the slope lubricates the particles which causes the soil mass to lose its strength and gravity acts to move the soil downhill. One of the best ways to solve this problem is to install horizontal drains in the slope to lower the ground-water level. However, installation of horizontal drains in caving materials has been extremely difficult.

The Bureau of Reclamation, in 1973, purchased a drill rig capable of horizontal, vertical, and angle drilling and the installation of horizontal drains in caving conditions. The drill is called an Aardvark, named after the "large, burrowing African Mammal."

After a hole is drilled to the required depth of the drain, a slotted plastic well screen is inserted in the larger diameter drill rod, the disposable drill bit is then released from the drill rod, and the rods are withdrawn over the plastic screen leaving the screen exposed to the inplace soils.

Usually three or four holes are drilled in a fan-shaped pattern with the drain piped converging to a single collector pipe. Holes are normally 100 to 500 feet long and up to 1,000 feet of drain can be installed in a day.

The Aardvark has been in almost continual use since its purchase, with much of the time being spent on the McClusky Canal in North Dakota. There, drains installed through its use have been very successful in preventing large landslides in the recently excavated canal.

The Aardvark drill has also been used to stabilize cut slopes for the Colorado State Highway Department and this winter was used to install drains in a coal waste embankment in West Virginia for the Mine Enforcement and Safety Administration.

The cost of drain installation will vary with soil conditions and ease of drilling. An analysis of the McClusky Canal showed a cost of $2.37 per foot for about 10,000 feet of drains.

Slide 18 - A 1/4-million-cubic-yard slide on the McClusky Canal in North Dakota. Slope stabilization by horizontal drains is being used extensively in this area.

Slide 19 - Aardvark drill rig has a crawler tractor carriage to get the rig into and out of the toughest terrain. It is very maneuverable and is easily operated by a two- or three-man crew.

Slide 20 - Slotted 1-1/2-inch diameter plastic well screen used in horizontal drain installation. Normal slot sizes vary from 0.010 to 0.030 of an inch.

Slide 21 - Drilling into night hours because once a hole is started, it has to be completed as overburden weight will cause hole squeeze.

Slide 22 - Completed drain showing substantial flow of drainage water. Small flows, however, often relieve hydrostatic pressures adequately for slope stability.

This completes my presentation of some recent Reclamation activities relating to soil mechanics engineering. Thank you.

BUREAU OF LAN" MANAGEMENT ACTIVITIES

in the

NATIONAL COOPERATIVE SOIL SURVEY

James S. Hagihara, Soil Scientist
Bureau of Land Management

(2) University Of California, Riverside - UCR is conducting a general soil inventory on 2 million acres located in the East Mojave Desert.

C. Bureau of Reclamation - The Bureau of Reclamation is conducting soil investigations on ten (10) sites located in Montana, Wyoming, Colorado, and Utah. These investigations are being conducted to develop criteria for rehabilitation end reclamation Of soils disturbed by mining and energy development. Approximately 25,000 acres are being studied under this agreement.

D. Soil Surveys are also being conducted under Joint cooperative agreements with the soil conservation districts and Soil Conservation Service.

The commitments to satisfy EIS needs and energy/mineral development demand soil survey date on practically all of the national resource lands in the future years. In view of this high demand for soils information, BLM will need very close cooperation end coordination with the Sol, Conservation Service, Universities, and other agencies to identify the objectives end priorities for accomplishing a soil survey that will satisfy the needs for multiple resource management 0" tile NRL.

uses, urban developments, or whatever uses we wish to discuss.

Three suggested outlines are included in the appendix. Probably any of these would be valid depending upon the order of the survey and the intended uses of the survey. The key point is to develop a format that users can use and understand. Again the new modular writing technique. appear to meet this need.

IL is critical that the reader be told in laymen terms the order of the survey and the degree of reliability or competence of each mapping unit for land "se planning. This is especially true of multi-order surveys.

Materials, interpretations or sections to be included need to be optional, and need to be geared to the criteria of the specific user. For example the Forest Service may use their own criteria and methods of discussing timber production, or BLM use their criteria for recreational uses of public lands etc.

One Forest Service region suggested a tabular format be considered for mapping unit descriptions for Order 3 and Order 4 survey especially. An example is included in the appendix to this report. These types of descriptions cannot be published until the Linolex procedures are refined, or unless a Linolex machine is available to the state or cooperating agency.

Recommendations:

1) We use the modular writing format for all orders of soil surveys.

2) That the tabular mapping unit description format be tested in one or two areas for Order 3 end Order 4 surveys, for local or "in-house" use at this time.

3) That the content of the report remain flexible. Make mapping unit descriptions and interpretations meet the anticipated needs of the soil survey over its expected life span.

Charge 4 - Summarize problems experienced with the new map procedures and new text procedures. Prepare recommendations on how to correct problems.

All states were contacted for their comments on this charge. The following outlines the major areas of problems in map compilation and manuscript preparation, followed by recommendations to overcome these problems.

Map Compilation

Instructions

Problem: Some states are having problems using Carto instructions for map compilation. Apparently more one to one training is needed in map compilation. Part of the problem appears to be in a lack of understanding of the language of cartographers by field personnel.

Recommendation:

1) Cart" and states having problems get together and arrange needed training for key state people.

Flow of material to and from Cart"

Problem: There is no consistant or smooth flow of map compilation materials to and especially from Carto.

Recommendation:

2) Carto work with states to develop an even flow schedule for routing soil map compilation materials with sufficient lead time scheduled. If either Cart" or the state fails to adhere to the schedule, adequate advance notice is needed to advise the other of the delays, to permit adjustments in schedules, and work assignments.

Problem: Considerable time is spent on compiling drainage and cultural overlays to orthophoto quads. There is also lost time in shipping to Carto for their input and returning to the states.

Recommendation:

3) Test the use of U.S.G.S. topo drainage overlays and cultural overlays. States can make minor changes and edits as needed.

Drafting Help

problem: Capable drafting help appears to be available as WAE's or through contracting. However uneven flows of compilation materials, with large gaps of down time leads to numerous turnovers in student WAE help. This means considerable training time for new compilation teams.

Recommendation: This conference suggests the following alternatives; a) the administrator return map compilation to the Carto units, and provide them with adequate WAE help to complete the Job in a reasonable time OR b) keep map compilation in the states, provided the flow of materials will be such that there will be no large periods of "down time." In some case8 possibly two or more states could combine map compilation in one office to increase efficiency.

Text Preparation

Problem:

Recommendation:

of the scs-SOILS-5 forms.

Recommendation:

9) States make full use of the new procedures for developing the SCS-SOILS-5's. These new procedures should be distributed by the Principal Soil Correlator as soon as possible.

Recommendation:

IO) Where problems still exist, states should request assistance and/or training from appropriate TSC staff members on completing the SCS-SOILS-S's--especially the first "3 blocks."

Computer Printouts

Problem: GPO requirements on page sires, type styles and size etc., places limits an tables, especially, those not currently in the Linolex or related programs. This limit means we cannot, at this point, print tables of "unique management" in our modular written soil surveys.

Recommendation:

11) This conference urges that a computer program, or capability, be developed to allow unique or local tables for inclusion in soil survey manuscripts

OR

states be provided Linolex or linolex compatible word processing equipment to produce their own programs and tables so as to better localize soil survey manuscripts.

Recommendation:

12) "he W.O. develop a program to tabulate lend capability class, subclass or where needed units, by mapping "nits.

Publishing Soil Maps

Problem: Many states have gone LO orthophoto quads for publication base maps at a 1:24,000 scale. This meets the need of many of our users. However recent cost studies indicate that publishing in the full 7½ minute quad format has greatly increased and we may need to publish in the stripped 2½ X 7½ minute format.

We need to include costs of map compilation with publication costs to determine if costs of publishing in the full 7½ minute format is prohibitive.

Recommendation:

13) States be given the option of publishing at full 7½ minute format, especially where requested by local users.

use of Soil survey

Problem: Possible misuse of sail surveys is a real problem. As a study in the northeast indicates, many engineers are misusing estimated data.

Recommendation:

14) Further study feasibility of including estimated percent passing sieves, liquid limits and plasticity index, in published surveys and see if their omission would reduce chances of misuse of published soil surveys.

Appendix H is an additional example of modular writing for complexes and associations. The master guide and "fill in the blanks" were developed for use in Montana but should be applicable throughout the west in writing complex and/or association descriptions.

Committee 1:

L. D. Giese
R. Gilkerson
* J. Hagihara
* R. Huff
* J. Jay
* L. Langan
* K. Larson
R. Mayko
* B. Meurisse
* R. Mitchell
* G. Nielson
* R. W. Kover, Chairman

* Present at conference

APPENDIX D

INTRODUCTION

Purpose of soil resource inventory (SRI)

Kind of SRI (Order 1, 2, or 3, etc.) - Mostly 3 or 4

Kinds of mapping units (e.g. combination of landform and soils)

Ho,, SRI was made (photo interpretation, field checking etc.)

DESCRIPTION OF AREA

Location and size

Private land area

Geology & general geomorphology

Climate

DESCRIPTION OF LANDFORM "NITS (if included in mapping)

Occurrence - How formed

Shape

Slope

Drainage density

Etc.

DESCRIPTION OF SOIL UNITS

Characteristics (Table form)

Inclusions (Table form)

INTERPRETATIONS FOR LANDFORM "NITS (if included in mapping and if desired)

Criteria

Table of Interpretations

INTERPRETATIONS FOR SOIL UNITS

Criteria

Table of Interpretations

APPENDIX

Soil Taxonomy

Glossary

Laboratory Analyses

Literature Cited

Note: If geologic structure end/or vegetation are combined with the soil units to obtain Ecological Land Units, then the descriptions and interpretation criteria must be included. Then the interpretations would be made for ELU's.

APPENDIX E

DRAFT FORMAT FOR PUBLICATION OF BLM SOIL INVENTORY REPORTS

A. Introduction - location, extent, objectives and purpose of inventory.

B. Inventory methods and how to use report. Discussion should be oriented to familiarize user on how to use report.

- Meaning of mapping units and mapping unit symbols.
- Significance of inclusions in mapping unit.
- Use of soil interpretations.
- Use of general soil map and detailed sheets.
- Discuss Order 1, 2 or 3 with explanation of use.

C. Napping units

-Description of mapping unit with acreage.
-Description and location Of major inclusions Of components.
-General soil map or detailed map.

D. Soil use and management

-Identify suitabilities and limitations for various land management practices.
-Table (soil properties and qualities).

E. Soil genesis and classification.

F. General nature of the area.

G. Appendix - (Soil Series Descriptions).

H. References.

(We feel the report should be written to assist the <u>user</u> in making resource management decisions. Thus, the interpretations and soil management sections should be up front. The technical material such as laboratory analyses end soil series descriptions should be in the back).

APPENDIX F

The following format suggestion is primarily for Orders 3 and 4, but should apply to any order.

I. Introduction

A. Purpose of the Survey

E. How the Survey was made

1. Basis for mapping units, that is, what factors were given consideration. This might include (a) soils, (b) landfarm, (c) slope, (d) lithology, (e) vegetation.

2. Scale of mapping

II. General Information

A. People end their use of the land

B. Climate

C. Geology - Geomorpho logy

D. Vegetation - broad description of native or predominant vegetative types

III. Description of the Soils

Describe the soils in terms of the lowest taxonomic level at which correlated. Follow with descriptions of each mapping unit and with a summary of major interpretations. For example, if series were the lowest taxa, describe the series and follow with a description of the mapping units. However, if the lowest taxonomic level is the family or higher, describe the map unit as follows:

Map Unit Symbol	Constituent Soils	Proportion
20	Andic Xerochrepts; medial over loamy-skeletal, mixed, frigid family, 10-30% slopes	50%
	Lithic Xerochrepts, loamy-skeletal, mixed frigid family, 15-40% slopes	40%
	Inclusions of Andic Xerochrepts, fine-loamy, mixed, frigid family	10%

Provide an example of each soil profile as follows:
Surface
Subsoil
Substratum

Describe the map unit with other appropriate information such as landform, lithology (bedrock), elevation range, annual precipitation, vegetation or dominant uses.

Follow this with a summary of major interpretations.

IV. Interpretations

This section could be primarily tables of interpretations for each map unit. The tables should express soil capabilities or limitations in quantitative terms where possible. Otherwise, use qualitative ratings. In either case, provide an explanation of each column heading.

V. Appendix

1. Soil identification legend
2. Maps
3. laboratory data
4. Literature cited

(Specifically the comments are for Charge 2, but include Charge 3, since I don't see the necessity for distinguishing unique areas. Rather, the emphasis should be on the order of survey)

APPENDIX G

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

R-5

REPLY TO: 2550 Soil Surveys

December 10, 1975

SUBJECT: California Soil Survey Committee, Soil Classification Sub-Committee

TO: Richard W. Kover, Asst. State Soil Scientist
Soil Conservation Service, State Office
P. 0. Box 1019
Davis, California 95616

Enclosed are copies of Susan Crosswhite's Soil Identification Legend end the description of Mapping Unit 14A (Holland-Musick Association, O-307. slopes) that apply to the Eldorado National Forest Soil Survey Area #724.

I am sending the mapping unit description to you for your review and consideration as a proposed format for mapping unit descriptions in reconnaissance soil surveys, such as our Soil Resource Inventories (SRI), of an Order 3 intensity.

I believe the table format with the accompanying derailed profile descriptions and ranges in characteristics for each mapping unit component as found in the Survey Area can be designed to cover all the needs of a mapping unit description, as required for detailed soil surveys, but will take less time to write. I also believe the table format will greatly facilitate the use and understanding of our reports and mapping.

Please understand that the enclosed mapping unit description is Susan's first approximation with very little in the way of guidelines from me. You should note that the pen and ink additions and changes made by me have not been confirmed by Susan. I made them from her detailed descriptions of the mapping unit component; so that the table information more closely fits my ideas of what should be displayed. If I were working up the M.U. descriptions for a surrey area, I would very likely add and/or delete some columns. With your understanding of NCSS and SCS requirements, you most likely can make additional improvements. Because of the above, please accept the enclosed material as an idea, not a finished product.

We still feel that we need to devise an easier end quicker way to describe our mapping units in a reconnaissance survey because of the time interval involved in completing this type of survey. Because of this, we feel we should present something to the NCSS Program and request the needed changes. The SCS will be encountering this same problem in the near future; so we would like to pool our ideas and present a united front to the Western Regional Technical Work-Planning Conference.

Dick Huff suggested that I send this to you for Committee consideration.

S/Art Sherrell

ART SHERRELL, Soil scientist
Watershed Management Staff

APPENDIX G

Eldorado National Forest, California
Soil Survey Area #724
September 1975

An example of a proposed format
for mapping unit descriptions
for reconnaissance soil surveys
of a 3rd Order of intensity.
(Forest Service,
Soil Resource Inventory)

(All parts of the mapping unit
description are based on data collected
within the Survey Area).

Holland-Musick Association, 0-30% Slopes (14A)

The soils of this mapping unit are derived from granitic bedrock. They occur on gently undulating slopes to moderately steep mountain slopes. This unit consists of 50% Holland soils and 40% Musick soils. Included areas of Shaver soils make up the remaining 10%. The Holland soils usually occupy the rolling to hilly portions of the unit while the Musick soils occupy the undulating to gently rolling areas. Vegetation consists of ponderosa pine, sugar pine, incense cedar overstory with a mixed brush understory of manzanita, ceanothus, and bearclover. Site class ranges from II to III.

APPENDIX C

TABLE--SOIL MAPPING UNIT DESCRIPTIONS

Mapping Unit Symbol	Slope Range	Mapping Unit Components	Geographic Position	Typical Vegetation Cover	Soil Profile Description: Surface Soil	Subsoil	Substratum
14A	0-30%	Holland loam - 50% 0-30% slopes	mooth to moderately steep ranitic mountain Slopes	Mixed conifer; ponderosa pine, sugar pine, incense cedar with bear clover, manzanita, and ceanothus understory	pale brown and brown, medium acid, loam and sandy loam with weak granular structure	light brown, medium acid, clay loam and sandy clay loam with strong sub angular blocky structure	ery pale brown, trongly weathered ranitic bedrock
		Musick loam - 40% 0-10% slopes	mooth to gent y undulating ranitic mountain Slopes	Mixed conifer; ponderosa pine, sugar pine, incense cedar with ceanothus and/or manzanita understory	grayish brown, slightly acid, loam with moderate granular structure	reddish brown to red, slightly to medium acid, sandy clay loam and sandy clay with moderate prismatic and strong, angular blocky structure	trong brown and ellowish red, edium acid, sandy oam grading to ighly weathered ranitic bedrock
		Inclusions - 10% Shaver sandy loam					

APPENDIX G

TABLE--SOIL CHARACTERISTICS AND QUALITIES

Mapping Unit Symbol	Mapping Unit Components	Effective Depth	Erosion Potential	Hydrologic Group	Natural Drainage	Runoff	AWC (Inches)	Subsoil Perm.	Present Use
14A	Holland loam - 40% Musick loam - 50% Inclusions - 10%	60-80" 40-80"	Moderate Mod.tohigh	B C	Good Good	Medium Medium	10"+ 8"+	Mod.slow Mod.slow to slow	Timber Timber

HOLLAND SERIES

The Holland series is a member of the fine-loamy, mixed, mesic family of Ultic Haploxeralfs. These soils have developed in place from granitic rocks. They occur on smooth to moderately steep mountain slopes. Typical vegetative cover consists of ponderosa pine, sugar pine, incense cedar, bearclover, manzanita, and ceanothus. Typically, Holland soils have pale brown and brown, medium acid, loam A horizons; light brown, medium acid, clay loam and sandy clay loam B2t horizons grading to strongly weathered granitic bedrock.

<u>Representative Profile</u>: Holland loam, located near the Middle Creek-Long Canyon Road approximately ¼ mile north of the intersection with Long Canyon Road, NE¼ SE¼ of Section 1, T.10N., R.15E., MDB&M.

O1 1½ - 0"--Leaf litter

A11 0- 5"--Pale brown (10YR 6/3) loam, very dark grayish brow" (10YR 3/2) moist; weak very fine granular structure; soft, friable, nonsticky and nonplastic; abundant very fine and fine, plentiful medium roots; many fine interstitial pores; medium acid (pH 6.0) abrupt wavy boundary. (3 to 8 inches thick)

A12 5-13"--Brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) mist; moderate fine granular structure; slightly hard, friable, nonsticky, nonplastic; plentiful very fine and fine, abundant medium and coarse roots; many fine interstitial and tubular pares; medium acid (pH 6.0); clear wavy boundary. (4 to 7 inches thick)

B1 13-23"--Pale brow (10YR 6/3) sandy clay loam, brow,, (10YR 5/3) moist; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky, nonplastic; very few thin clay films in pores; few fine, plentiful medium and coarse roots; common fine and medium interstitial and tubular pores; strongly acid (pH 5.5); clear wavy boundary. (8 to 13 inches thick)

B2t 23-51"--Light brown (7.5YR 6/4) sandy clay loam, strong brown (7.5YR 5/6) mist; strong medium subangular blocky structure; hard, very firm, stick,-, slightly plastic; common thin clay films in pores and on ped faces; few medium roots; common fine and medium tubular and interstitial pores; medium acid (pH 6.0); clear wavy boundary. (25 to 35 inches thick)

B3t 51-63"--Very pale brown (10YR 7/3) sandy clay loam, pale brown (10YR 6/3) moist; massive; slightly bard, firm, sticky, and slightly plastic; few thin clay films in pores; no roots; few fine tubular and interstitial pores; medium acid (pH 6.0).

Grades to highly weathered granitic bedrock.

<u>Range in Characteristics</u>: The solum ranges from 40 to over 75 inches thick. Depth to paralithic contact is more than 60 inches. Mean annual soil temperature at a depth of 20 inches is 52 to 58° F., and these soils become dry for 60 consecutive days between the depths 5 and 15 inches. The A horizon ranges brow" to dark grayish brown, dry, usually 10YR 4/2, 4/3, 5/3 or 7.5YR 5/4, 4/4; the upper few inches are normally pale brow". Moist colors range dark brown to very dark grayish brown, usually 10YR and 7.5YR 2/2, 3/2, 3/3. The A horizon is slightly to strongly acid. It is coarse sandy loam, sandy loam or loam and may or may not contain iron concretions. It averages 35 to 50% base saturation. There is a" A3 or B1 horizon grading to the B2t. The B2t horizon is light brown to yellowish red in 7.5YR or 5YR hue. It is sandy clay loan, or clay loam and is medium to strongly acid. The B3t and/or C horizon has a hue of 7.5YR or 10YR. This soil is well drained. Surface runoff is medium to rapid; permeability is moderately slow. The deeply weathered parent rock is slowly permeable. Erosion hazard is moderate to high.

APPENDIX G

MUSICK SERIES

The Musick series is a member of the fine-loamy, mixed, mesic family of Ultic Haploxeralfs. These soils have developed in place from granitic rocks. They occur on smooth to gently undulating mountain slopes. Typical vegetative cover consists of ponderosa pine, sugar pine, incense cedar, ceanothus and/or manzanita. Typically, Musick soils have grayish brown, slightly acid, loam A horizons; reddish brown and red, slightly to medium acid, clay loam B2t horizons; and strong brown end yellowish red, medium acid, sandy loam C horizons grading to weathered granitic bedrock.

<u>Representative Profile</u>: Musick loam, located near Short Place, Pacific Ranger District, Eldorado National Forest, SE¼ SE¼ of Section 24, T.11N., R.13E., MDB&M.

O1 1½ - 0"--Leaf litter

A11 0 - 7"--Grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, friable, nonsticky, nonplastic; abundant very fine and fine, plentiful medium roots; many very fine interstitial pores; slightly acid (pH 6.5); abrupt wavy boundary. (5 to 10 inches thick)

A3 7 -11"--Pale brown (10YR 6/3) loam, dark brown (7.5YR 4/4) moist; moderate to7

B21t

B22t

B3

C1

The B3 or B3t horizon is light yellowish brown to light red in 5YR, 7.5YR or 10YR hue grading to the C horizon. The C horizon is reddish yellow, yellowish red to strong brown in 5YR, 7.5YR or 10YR hue. It is coarse sandy loam or sandy loam.

This soil is well drained; permeability is moderate to moderately slow; runoff is medium to rapid. Erosion hazard is moderate to high.

MASTER GUIDE USDA-SCS/1-20-76

CONSOCIATION
MAPPING UNIT DESCRIPTION

(Symbol) (Series name) (texture), (number) to (number) percent slopes.

This (depth), (drainage) drained (slope adjective) to (and) (slope adjective) soil is in the (location in survey area) part of the (county or area). It formed in (parent material) on (landscape) at elevations of (number) to (number) feet. Slopes are mainly (short, medium, or long) in length. The average annual precipitation is about (number) inches, and the mean annual air temperature is about (number) degrees F. The average growing season is about (number) days.

Small areas of (soil name), (soil name), and (soil name) soils were (was) included in mapping.

NOTE: Remember! Name only those inclusions that are significant. If there are none, then don't mention any. In a discussion of the included soils, give information on landscape position. This will help give a mental and visual perspective of the position relationship of the included soils with the main soil comprising the mapping unit. Also, mention the contrasting characteristic(s) of each inclusion. In addition, discuss management opportunities or limitations for unique inclusions that strongly influence use and management of the unit. An important point to consider in regard to how much discussion is important on the management aspect of inclusions is their significance to use and management relative to the total amount of the inclusion. For example, a 2 percent inclusion in a 50-acre delineation amounts to one acre while in a 1000-acre delineation the inclusion amounts to 20 acres. Rock outcrop or very wet soils are quite significant while low-producing gravelly clay soils are not as significant. Following are five examples of describing inclusions:

(1) The nearly level Alpha soil occupies narrow bottomland areas along intermittent drains. It is subject to flooding in early June subjecting early spring planted crops to severe damage.

(2) The moderately sloping Beta soils is on ridgetops. This shallow soil is very droughty and thus poorly suited for cultivated crops.

CONSOCIATION MAPPING UNIT DESCRIPTION

(3) The moderately steep Gamma clay loam occupies short breaks below hill tops. This calcareous soil produces low yields from cultivated crops. Yields can be substantially increased by applications of barnyard manure and phosphate fertilizer.

(4) Rock outcrop on small knolls can be easily farmed around.

(5) The nearly level, poorly drained Zeta clay soils occupy small depressions. This soil remains wet until late June and is not suited for cultivation. It can be easily farmed around:

In a typical profile of this (series name) soil the surface layer is (dry color) (texture) about (number) inches thick. The subsurface layer is (dry color) (texture) about (number) inches thick. The subsoil is (dry color) (texture) about (number) inches thick. The substratum is (dry color) (texture) to about (number) inches. Below this, to a depth of 60 inches, is (very gravelly sand, sandstone, shale, or etc.).

Permeability is (adjective rare). The available water capacity is

NOTE: If the permeability is significantly different, as in contrasting textural families or substratum phases, express permeability as, for example: "Permeability is slow to a depth of about 24 inches and rapid below.'

(adjective amount). The effective rooting depth is about (numerical) inches. The average annual wetting depth of the soil under native vegetation is about (number) inches. Surface runoff is (adjective rate),

NOTE: Use information collected on mot depth characteristics of native vegetation along with other features like depth to lime, depth to ca horizons, etc. to determine this. The depth at which roofs grade in abundance from "common" to "few" might be a good clue as to the average annual wetting depth.

and the erosion hazard is (adjective degree) from (wind and/or water).

NOTE: Include in the above paragraph other important soil characteristics and properties that affect soil use and behavior. Examples are: "A seasonal high water table is between 20 and 40 inches during April and May." "This soil is subject to flooding in late May and early June." "This soil is strongly affected by alkali below about 20 inches.",

APPENDIX B

CONSOCIATION MAPPING UNIT DESCRIPTION

This soil is used for (dryland or for irrigated cropland, range, or woodland). Dryland crops are mainly (for example: wheat, barley, oats, etc.). Irrigated crops are mainly (for example: sugar beets, corn for silage, potatoes, alfalfa, etc.).

> (Note: Enter here a discussion on soil management needs for growing cultivated crops. Identify the soil property or properties and hazards that affect the intended use. State the effect of the soil property or properties and hazards on the intended use. State management practice or practices needed to overcome the soil property or properties and hazards. In the management discussion, do not reiterate the interpretation tables soil limitation adjectives (slight, moderate, severe). Discuss soil properties and hazards and corrective measures possible as alternatives. Following is a sample discussion:
>
> "Minimum tillage, contour cultivation, grassed waterways, and stripcropping help control erosion [illegible]. These practices also help to control runoff. Crop residue [illegible] helps to maintain good soil tilth and also helps to control erosion. Chiseling stubble fields in the fall on the contour or across the slope helps to control runoff and water erosion. [illegible] also helps to conserve moisture and allows for improving soil tilth through the breakdown of hard clods over winter from the action of freezing and thawing. Chiseling also promotes better aeration." Irrigation methods suitable for this soil are borders, furrows, corrugations, and sprinklers, but are generally governed by the crop. Sprinkler irrigation is well suited to most crops. The furrow and corrugation methods are well suited to row crops. Borders are well adapted to alfalfa, small grains and pasture. Regardless of the irrigation method used, water must be applied carefully to avoid applications of too little or too much for optimum crop production.)

This soil is well suited for range. The native vegetation is dominated by (species), (species), (species), and (species). When the range deteriorates, the proportion of (species), (species), and (species), which are highly desirable native plants, diminishes, and the proportion of forbs, woody shrubs and other undesirable plants becomes greater.

> NOTE: Enter here a discussion on range management. For example, "Seeding is advisable if the range is in a deteriorated condition. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suited for seeding. This soil is suited for use of machinery for preparing the seedbed and drilling. Waterspreading is beneficial where water is available."

NOTE: The following provides soil interpretations for windbreaks and is to be used in areas where this practice is applicable. If the soil is not suited for windbreaks, use the first paragraph below. If the soil is suited for windbreaks, use the second paragraph below.

This soil is not suited for windbreaks because it is or has (list limiting soil properties as for example: steeper than 15 percent slopes, very low available water capacity, a water table within 10 inches of the surface during most of the growing season, strongly affected by saline and/or alkali, etc.)

This soil is suited for windbreaks. (This second sentence should identify limiting soil properties, if there are any, and the effect--for example: "The low available water capacity of this soil restricts the choice of trees and shrubs to those that are drought resistant." "The salt content of this soil restricts the choice of trees and shrubs to those that are salt-tolerant." "The seasonal high water table in this soil restricts the choice of trees and shrubs to those that are water-tolerant." Suited tree species include (species), (species), (species), (species), and (species). Suited shrub species include (species), (species), (species), (species), and (species). Under irrigation this soil is suited for (species), (species), (species), (species), and (species) trees, and (species), (species), (species), (species), and (species) shrubs.

This (series name) soil is suited for production of (tree species). It is capable of producing about (number(s)) total cubic feet, or (number(s)) board feet per acre (Scribner rule), of the named merchantable timber species, respectively. These produc-

CONSOCIATION MAPPING UNIT DESCRIPTION

tion levels are from fully stocked, even-aged, unmanaged stands of (number(s))-year old trees, respectively.

> NOTE: In the above three sentences, if just one timber species is named, combine the second and third sentences into one sentence by striking out the following words and parts of sentences: "the named, "species respectively. "These production levels are" and "respectively."

The primary restriction(s) in its use for timber production is (are) (very slowly permeable subsoil, steep slope, shallow soil depth, stoniness, etc.)

> NOTE: Enter here a brief discussion about management. Example statements: "Conventional methods can be used for tree harvest, but may be restricted during winter months because of heavy snow-pack." "Care in road construction and other soil disturbing operations should be exercised to help control erosion." "Reforestation, after harvest, must be carefully managed to reduce plant competition of undesirable understory plants." "The clay subsoil restricts the downward movement of tree roots, imposing a wind-throw hazard to mature trees." "The steepness of this soil restricts the kinds of equipment used in forest management activities and influences ease of operations." "Road construction is difficult because of the shallow depth to bedrock." "Trafficability of this wet soil is poor during the period March through April, restricting the use of mechanical equipment for tree harvest."

NOTE: In the following paragraph, information is given about soil interpretations for urban-related developments. It is important to keep in mind to tailor the interpretations to the area of need. For example, in Garfield County the interpretations should be confined to septic tank filter fields, foundations for homes and other buildings, and for roads. In Missoula County the interpretations should probably include, in addition to those listed above, those for sewage lagoons, sanitary landfills, and shallow excavations.

The primary limiting soil properties for most urban-related developments are (slow permeability), (seasonal high water table), (high shrink-swell), (flooding),

CONSOCIATION MAPPING UNIT DESCRIPTION

(slope), (shallow to bedrock), (frost heave), (etc.).

[NOTE: Following are a few sample statements identifying the potential use, effect, and soil property. "Septic tank filter field sewerage disposal systems require special design to overcome the soil limitations imposed by steep slopes and slow permeability." "The construction of homes with basements is restricted by bedrock." "The seasonal high water table can result in homes with basements being flooded in the spring." "The steep slopes and low inherent soil strength restricts the construction of homes." "Careful design and construction of roads is required to overcome the limitations imposed by the high shrink-swell and high frost action potential." "The very rapidly permeable substratum greatly restricts the use of this soil for sewerage lagoons."]

APPENDIX H

CONSOCIATION
M PPING UNIT DESCRIPTION

____

This ______________________, ______________ drained ______ to (and) ______________ soil is in the ______________ part of the ______________, is formed in ____

____

at elevations of ________ to ________ feet. Slopes are mainly ________ in length. The average annual precipitation is about ________ inches, and the mean annual air temperature is about ________ degrees F. The average growing season is about ________ days.

Small areas of ______________, ______________, and ______________ soils were (was) included in mapping. ______________________________

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In a typical profile of this ______________ soil the surface layer is ______________________________________ about ________ inches thick. The subsurface layer is ______________________________ about ________ inches thick. The subsoil is ______________________________ about ________ inches thick. The substratum is ______________________________ to about ________ inches. Below this, to a depth of 60 inches, is ______________________________.

Permeability is ____

APPENDIX H

CONSOCIATION MAPPING UNIT DESCRIPTION

The available water capacity is __________. The effective rooting depth is about ______ inches. The average annual wetting depth of the soil under native vegetation is about ________ inches. Surface runoff is ____________, and the erosion hazard is __________ from ____

This soil is used for ____.
Dryland crops are mainly ____.
Irrigated crops are mainly ____.

APPENDIX H

CONSOCIATION MAPPING UNIT DESCRIPTION

This soil is well suited for range. The native vegetation is dominated by ______________, ______________,

and ______________. When the range deteriorates, ______________

This soil is not suited for windbreaks because it is or has ______________

APPENDIX H

CONSOCIATION MAPPING UNIT DESCRIPTION

Under irrigation this soil is suited for ____________________, ____________________

____________, ____________________, ____________________, and

____________________ trees, and ____________________, ____________

____________, ____________________, ____________________, and

____________________ shrubs.

This ____________________ soil is suited for production of ____________, ____

____________________. It is capable of producing about

____________________ total cubic feet, or ____________________

board feet per acre (Scribner rule), of the named merchantable timber species, respectively. These production levels are from fully stocked, even-aged, unmanaged stands of

____________________-year old trees, respectively.

The primary restriction(s) in its use for timber production is (are) ____________

____

____

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The primary limiting soil properties for most urban-related developments are

____

APPENDIX H

CONSOCIATION MAPPING UNIT DESCRIPTION

Capability subclass ____________, dryland; ______________, irrigated.

COMPLEX
MAPPING UNIT DESCRIPTION

(Symbol) (Mapping unit name)

Included with this complex in mapping are small areas of (soil name), (soil name), (soil name), and (soil name) soils. These inclusions make up about (number) percent of this unit.

NOTE: Remember! Name only those inclusions that are significant. If there are none, then don't mention any. In a discussion of the included soils, give information on landscape position. This will help give a mental and visual perspective of the position relationship of the included soils with the main soil comprising the mapping unit. Also, mention the contrasting characteristic(s) of each inclusion. In addition, discuss management opportunities or limitations for unique inclusions that strongly influence use and management of the unit. An important point to consider in regard to how much discussion is important on the management aspect of inclusions is their significance to use and management relative to the total amount of the inclusion. For example, a 2-percent inclusion in a 50-acre delineation amounts to one acre while in a 1000-acre delineation the inclusion amounts to 20 acres. Rock outcrop or very wet soils are quite significant while low-producing gravelly clay soils are not as significant. Following are five examples of describing inclusions:

(1) The nearly level Alpha soil occupies narrow bottomland areas along inter-

mittent drains. It is subject to flooding in early June subjecting early spring planted crops to severe damage.

(2) The moderately sloping Beta soil is on ridgetops. This shallow soil is very droughty and thus poorly suited for cultivated crops.

(3) The moderately steep Gamma clay loam occupies short breaks below hill tops. This calcareous soil produces low yields from cultivated crops. Yields can be substantially increased by applications of barnyard manure and phosphate fertilizer.

(4) [redacted]

(5) [redacted] sions. This soil remains wet until late June and is not suited for culti- vation. It can be easily farmed around.

The (first named soil) soil is a (depth), (drainage) drained soil. It formed in (parent material) on (landscape).

NOTE: Delete from the last part of the preceding sentence the information on landscape if the landscape for all the major named soils in the complex is the same. This applies as well to the succeeding aragraphs(s) giving this &formation on the other major soil(s) in the complex.

In a typical profile of the (first named soil) soil the surface layer is (dry color) (texture) about (number) inches thick. The subsurface layer is (dry color) (texture) about (number) inches thick. The subsoil is (dry color) (texture) about (number) inches thick. The substratum is (dry color) (texture) to about (number) inches. Below this, Lo a depth of 60 inches, is (very gravelly sand, sandstone, shale, or etc.).

Permeability is (adjective rate). The available water capacity is

NOTE: If the permeability is significantly different, as in contrasting textural families “P67 0 0 1 1y i 138.96 Tm j E16 Tm6392.72004gq 8.880504gq 865.2799988 cm BI /W 144 /H 21 @ à

(adjective amount). The effective rooting depth is about (numerical) inches. The average annual wetting depth of the soil under native vegetation is about (number)

COMPLEX MAPPING UNIT DESCRIPTION

inches. Surface runoff is (adjective rate),

NOTE: Use information collected on root depth characteristics of native vegetation along with other features like depth to lime, depth to ca horizons, etc. to determine this. The depth at which roots grade in abundance from "common" to "few" might be a good clue as to the average annual wetting depth.

and the erosion hazard is (adjective degree) from (wind and/or water).

NOTE: Include in the above paragraph other important soil characteristics and properties that affect soil use and behavior. Examples are: "A seasonal high water table is between 20 and 40 inches during April and May." "This soil is subject to flooding in late May and early June." "This soil is strongly affected by alkali below about 20 inches."

NOTE: REPEAT INFORMATION IN THE ABOVE THREE PARAGRAPHS FOR EACH OF THE REMAINING MAJOR COMPONENTS OF THE MAPPING UNIT.

This complex is used for (dryland and/or irrigated cropland, range, or woodland). Dryland crops are mainly (for example: wheat, barley, oats, etc.). Irrigated crops are mainly (for example: sugar beets, corn for silage, potatoes, alfalfa, etc.).

NOTE: Enter here a discussion on soil management needs for growing cultivated crops. IMPORTANT! REMEMBER! COMPLEX MAPPING UNITS ARE MANAGED AS A WHOLE AND NOT ON THE BASIS OF THE INDIVIDUAL SOIL. Identify the soil property or properties and hazards of the named soils that affect the intended use. State the effect of the soil property or properties and hazards on the intended use. State management practice or practices used to overcome the soil property or properties and hazards. In the management discussion, do not reiterate from interpretation tables soil limitation adjectives (slight, moderate, severe). REMEMBER! DISCUSS SOIL PROPERTIES AND HAZARDS AND CORRECTIVE MEASURES POSSIBLE AS ALTERNATIVES. Following is a sample discussion:

"Minimum tillage, stripcropping, and crop residue utilization help to control erosion from wind. Crop residue utilization and applications of barn-

COMPLEX MAPPING UNIT DESCRIPTION

yard manure on the (series name) part helps to improve soil tilth, prevent soil crusting, and increase crop production.

"The only irrigation method suitable for soils in this complex is sprinklers. This method of irrigation is well suited to most crops. The very slow permeability of the (series name) part governs the rate and Irequency of water application."

NOTE: The following part on range is described in two different ways. The first paragraph should be used when the named components in the complex are all in the same range site. The second paragraph is to be used if the named components in the complex are in different range sites.

This complex is well suited for range. The native vegetation is dominated by (species), (species), (species) and (species). When the range deteriorates, the proportion of (species), (species), and (species), which are highly desirable native plants, diminishes and the proportion of forbs, woody shrubs and other undesirable plants becomes greater.

This complex is well suited for range. The bulk of the forage for grazing is produced by the (series name(s)) part(s).

NOTE: The fallowing sentence may or may not be needed. Strike out if "oe needed."

The least amount of forage for grazing is produced by the (series name) part. The native vegetation on the (series name) part is dominated by (species), (species), (species), and (species), (and) on the (series name) part by (species), (species), (species), and (species), and on the (series name) part by (species), (species), (species), end (species)

NOTE: The next sentence of the above "second" paragraph format must apply to the unit as a whole. The plant species named must be those that dominate in the unit as a whole. If one of the soils dominates the unit in terms of acreage as well as forage output potential, the plant species named might be entirely those produced from that single soil. Obviously, if all the soils are

COMPLEX MAPPING UNIT DESCRIPTION

in the same range site, as given in the "first" paragraph format, this poses no problem in what species to name]

When the range deteriorates, the proportion of (species), (species), and (species), which are highly desirable native plants, diminishes and the proportion of forbs and woody shrubs becomes greater.

NOTE: Enter here a discussion on range management.

IMPORTANT! REMEMBER! COMPLEX MAPPING UNITS ARE MANAGED AS A WHOLE AND NOT ON THE BASIS OF THE INDIVIDUAL SOIL. For example:

"Seeding is advisable if the range is in a deteriorated condition. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suited for seeding. This complex is suited for use of machinery for preparing the seedbed and drilling. Waterspreading is beneficial where water is available." NOTE: If one of the soils dominates the unit and is suitable for seeding or brush control, for example, it might be quite practical to apply practices accordingly. For example: "Seeding is advisable on the (series name) part if the range is in a deteriorated condition. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suited for seeding. Brush control practices for big sagebrush, silver sagebrush and rabbitbrush on the (series name) part is advisable to reduce competition to desirable forage species."

NOTE: The following provides soil interpretations for windbreaks and is to be used in areas where this practice is applicable. If the complex is not suited for windbreaks, use the first paragraph below. If the complex or part of the complex is suited for windbreaks, use the second paragraph below.

The soils in this complex are not suited for windbreaks because they are or have (list limiting soil properties if they are the same for each major soil, as for example: slopes steeper than 15 percent, very low available water capacity, a water table within 10 inches of the surface during most of the growing season, strongly affected by saline and/or alkali. Identify limiting soil property or properties for each of the named soils

COMPLEX MAPPING UNIT DESCRIPTION

in the complex if they are different. For example: "The (series name) part has a very low available water capacity. The (series name) part is strongly affected by saline and/or alkali. The (series name) part has bedrock at less than 10 inches.")

NOTE: If all the major soils in the complex are suited for windbreaks, use the first sentence in the paragraph below. If just part of the soils in the complex are suited for windbreaks, use the second sentence in the paragraph below.

This complex is suited for windbreaks. OR

The (series name) and (series name) part(s) of this complex are (is) suited for windbreaks. (This second sentence of this paragraph should identify limiting soil properties, if there are any, and the effect--for example: "The low available water capacity of the (series name) part restricts the choice of trees and shrubs to those that are drought resistant. The salt content of the (series name) part restricts the choice of trees and shrubs to those that are salt-tolerant. The seasonal high water table in the (series name) part restricts the choice of trees and shrubs to those that are water-tolerant."

NOTE: For the major soil(s) in the complex not suited for windbreaks give the following example information: "The droughty (series name) part is not suited for windbreaks." OK "The wet (series name) part is not suited for suited for windbreaks." OR "The alkali affected (series name) part is not suited for windbreaks.")

NOTE: If the major soils in the complex are all suited for the same tree and shrub species, use the first format below as a continuation of the above paragraph. If the major soils in the complex are suited for different shrub species, use the second format below as a continuation of the above paragraph.

Suited tree species include (species), (species), (species), (species), and (species).
Suited shrub species include (species), (species), (species), (species), and (species).
Under irrigation this complex is suited for (species), (species), (species), (species),

COMPLEX MAPPING UNIT DESCRIPTION

and (species) trees, and (species), (species), (species), (species), and (species) shrubs.

For the (series name(s)) part(s), suited tree species include (species), (species), (species), and (species). Suited shrub species include (species), (species), (species), and (species). Under irrigation rhe (series name(s)) part(s) is (are) suited for (species), (species), (species), (species), and (species) trees, and (species), (species), (species), (species), and (species) shrubs. For the (series name(s)) part(s), suited tree species include (species), (species), (species), and (species). Suited shrub species include (species), (species), (species), (species), and (species). Under irrigation the (series name(s)) part(s) is (are) suited far (species), (species), (species), (species) , and (species) trees, and (species), (species), (species), (species), and (species) shrubs. For the (series name@)) part(s), suited tree species include (species), (species), (species), (species), and (species). Suited shrub species include (species), (species), (species), (species), and (species). Under irrigation the (series name(s)) part(s) is suited for (species), (species), (species), (species), and (species) trees, and (species), (species), (species), (species), and (species) shrubs,

The soils in this complex are suited for woodland. The (series name) part is suited for the production of (tree species). It is capable of producing about (number(s)) total cubic feet, or (number(s)) board feet per acre (Scribner rule), of the named merchantable timber species, respectively. These production levels are from fully stocked, even-aged, unmanaged stands of (number(s))-year old trees, respectively.

NOTE: In the above last three sentences, if just one timber species is named, combine the second and third sentences into one sentence by striking out the following words and parts of sentences: "the named," "species respectively. These production levels are" and "respectively." This convention applies co the following sentences dealing with production, also.

The

COMPLEX MAPPING UNIT DESCRIPTION

the interpretations should probably include, in addition to those listed above, those for sewerage lagoons, sanitary landfills, end shallow excavations:

The primary limiting properties of soils in this complex for most urban-related developments are: for the (series name(s)) part(s) (name limiting soil properties); for the (series name(s)) part(s) (name limiting soil properties); and for the (series name) part (name limiting soil properties).

NOTE: Following are a few sample management statements identifying the potential use, effect, and soil property. "Septic tank filter field sewerage disposal systems require special design to overcome the soil limitations imposed by steep slopes and slow permeability of the (series name) part." "The construction of homes with basements is restricted by bedrock in the (series name) part." "The

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This complex consists of ______________________ soils on ______________________

soils on ______________________ and ______________________

soils on ______________________ in the ______________________

part of the ______________________ at elevations of ________ to ________ feet. The average annual precipitation is about ________ inches, and the mean annual air temperature is about ________ degrees F. The average growing season is about ________ days. The ______________________ makes up about ____ percent of the mapping unit, the ______________________ about ____ percent, and the ______________________ about ____ percent.

Included with this complex in mapping are small areas of ______________________, ______________________, and ______________________ soils. These inclusions make up about ________ percent of this unit. ______________________

____

The ______________________ soil is a ______________________ drained soil. It formed in ______________________ on ______________________

In a typical profile of the ______________________ soil the surface layer is ______________________ about

APPENDIX H

COMPLEX MAPPING UNIT DESCRIPTION

inches thick. The subsurface layer is ________________________________ ____ about __________ inches thick. The subsoil is ____ about ________ inches thick. The substratum is ______________________________ ____________________________________ to about ________ inches. Below this, to a depth of 60 inches, is ____

Permeability is ____ The available water capacity is ______________. The effective rooting depth is about __________ inches. The average annual wetting depth of the soil under native vegetation is about ________ inches. Surface runoff is ____________, and the erosion hazard is ______________ from ____ ____ ____ ____ ____ ____

The ____________________ soil is a ______________________________ ____________________ drained soil. It formed in ____________________ ____ on ______________ ____

In a typical profile of the ______________________________ soil the surface layer is ____ about ________ inches thick. The subsurface layer is ______________________ ____________________________________ about __________ inches thick. The subsoil is ____ about ________ inches thick. The substratum is ______________________________ ____________________________________ to about ________ inches. Below this, to a depth of 60 inches, is ____

APPENDIX H

COMPLEX MAPPING UNIT DESCRIPTION

Permeability is ____. The available water capacity is ________________. The effective rooting depth is about ____________ inches. The average annual vetting depth of the soil under native vegetation is about ____________ inches. Surface runoff is ______________, and the erosion hazard is ______________ from ____

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The ________________________ soil is a ____________________________, ________ ____________________ drained soil. It formed in ________________________

________________________________ ________________________

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In a typical profile of the ____________________________ soil the surface layer is ____________________________ about __________ inches thick. The subsurface layer is ____ about ________ inches thick, me subsoil is ________________ ________________________________ about ________ inches thick. The substratum is ____________________________ ____________________ to about ____________ inches. Below this, co a depth of 60 inches, is ____

Permeability is ____

The available water capacity is ______________. The effective rooting depth is about ____________ inches. The average annual wetting depth of the soil under native vegetation is about ____________ inches. Surface runoff is ____________, and the erosion hazard is ________________ from ____

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SOIL MAPPING UNIT DESCRIPTION

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This complex is used for ____.

Dryland crops are mainly ____.

Irrigated crops are mainly ____

____.

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This complex is well suited for range. The native vegetation is dominated by

____

, and ____. When the range deteriorates,

COMPLEX MAPPING UNIT DESCRIPTION

the proportion of ______________, ______________,

and ______________, which are highly desirable native plants, diminishes and the proportion of forbs, woody shrubs and other undesirable plants becomes greater.

This complex is well suited for range. The bulk of the forage for grazing is produced by the ______________ part(s). The least amount of forage for grazing is produced by the ______________ part. The native vegetation on the ______________ part is dominated by ______________

______________, ______________, ______________,

and ______________, (and) on the ______________ part by

______________, ______________, ______________,

and ______________, and on the ______________ part by

______________, ______________, ______________,

and ______________. When the range deteriorates, the proportion of

______________, ______________, and ______________

______________, which are highly desirable native plants, diminishes, and the proportion of forbs and woody shrubs becomes greater.

APPENDIX H

COMPLEX MAPPING UNIT DESCRIPTION

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The soils in this complex are not suited for windbreaks because they are or have ______________________________

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This complex is suited for windbreaks, OR

the ______________ and ______________ part(s) of this complex are (is) suited for windbreaks. ______________________________

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Suited tree species include ______________________________ ______________, ______________ ______________, and ______________. Suited shrub species include ______________, ______________, and ______________. Under irrigation this complex is suited for ______________ ______________, and ______________ trees, and ______________ ______________, ______________ ______________, and ______________ shrubs.

For the ______________ part(s), suited tree

APPENDIX H

COMPLEX MAPPING UNIT DESCRIPTION

species include ____________, ____________ ____________, ____________

____________, ____________, and ____________.

Suited shrub species include ____________

____________, and ____________

Under irrigation the ____________ part(s) is (are)

suited for ____________

____________, ____________ and ____________

trees, and ____________ ____________, ____________

____________, ____________ and ____________

shrubs. For the ____________ part(s), suited tree species

include ____________

____________, ____________, and ____________

Suited shrub species include ____________

____________, ____________, and ____________

Under irrigation the ____________ part(s) is (are) suited

for ____________, ____________

____________, and ____________ trees, and ____________

____________, ____________, ____________

____________, and ____________ shrubs. For the ____________

____________ part(s), suited tree species include ____________

____________, ____________

____________, and ____________. Suited shrub species

include ____________ ____________

____________, ____________, and ____________

Under irrigation the ____________ part(s) is suited for

____

____________, and ____________ trees, and

____

____________, ____________, and ____________

shrubs.

APPENDIX H

COMPLEX MAPPING UNIT DESCRIPTION

The primary limiting properties of soils in this complex for most urban-related developments are: for the ____________________ part(s) ____________________ ;

for the ____________________ part(s) ____________________ ; and for the ____________________ part ____________________

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COMPLEX MAPPING UNIT DESCRIPTION

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Capability subclass _________, dryland; _________, irrigated.

WESTERN REGIONAL TECHNICAL WORK-PLANNING
CONFERENCE OF THE COOPERATIVE SOIL SURVEY

Phoenix, Arizona, February 9-13, 1976

Committee 2 - Improving Soil Survey Techniques

Charges

A. Inventory remote sensing techniques being used or tested in the region and evaluate potential for application to soil surveys.

B. Evaluate the use of over-flights as a technique for improving and accelerating soil surveys.

C. Evaluate the use and application of slope maps prepared by U.S.G.S. for improving legend design and accuracy of mapping.

A. Remote Sensing Techniques

The committee contacted representatives of agencies engaged in soil surveys in each state of the region to inventory current applications of remote sensing techniques. Most states reported relatively little activity directly related to soil survey although a number of projects are underway in related fields of interest such as vegetative cover mapping and land use mapping. A summary of comments received from around the region follows:

Arizona: Soil associations mapped at 2 inch = 1 mile by standard methods were compared with patterns discernible on high altitude, small scale (½ inch = 1 mile) color photographs for the Lower Pantano Wash Area in Pima County, Arizona. This study was cooperative between SCS and the Office of Arid Land Studies to evaluate use of the high altitude photography to compile maps of major soil distribution for non-farm planning. The report has the larger scale association map on half-tone photo mosaic with the same delineations on an overlay of the small scale color photo. No discussion of the comparison is included. The scale difference seems no problem in using either map. The larger photo base has planimetric detail identified which might have been difficult on the color photo. The color photo shows a broader area and puts the survey area in better perspective with the surrounding landscape. Probably the color photo would have been an adequate field sheet for this survey but this evaluation was not reported.

Arizona also mentioned that the Forest Service has used color photography for soil mapping in that state with good results. Orthophoto maps received so far by SCS were of poor quality and clarity. This may be due to use of U-2 photos flown in November (extreme shadows) and/or processing problems. Several other states indicated they had had problems in quality of orthophotos.

The University of Arizona and SCS have recently printed a State General Soil Map on a 1:1,000,000 ERTS mosaic for limited distribution. The main publication is on a planimetric base.

Alaska: Vegetation maps have been prepared for parts of Alaska using satellite imagery and high altitude photography. The rather broadly defined vegetation types have a good correlation with soils at the great group level, provided some additional landform interpretations are made with the stereoscope. The correlation is not perfect and it cannot be extended beyond regional limits. (Certain great groups may have different vegetation in different regions, and the same vegetation may be common to different great groups in different regions.) Field checks are necessary, but vegetation maps from high-altitude photography are extremely useful for predicting the great group at any locality. Remote sensing appears to have much less application for distinguishing lower levels of soil classification, where much depends on subsurface profile characteristics.

California: The SCS has obtained NASA color IR enlarged prints for evaluation by fieldmen in Kings County and color IR transparencies are being evaluated in Santa Cruz, Marin, and Mendocino Counties. An ERTS (LANDSAT) color composite transparency and a few enlarged color prints are being utilized in Lassen, Tulare and Kern Counties. They recommend having these products on hand when the survey is initiated. Overall, these

Oregon: A false color mosaic of ERTS imagery has been compiled at 1:1,000,000 scale for the state. Black and white mosaics are also available. The mosaics have been used as an aid in compiling a state general soil map and coordinated legend with Idaho and Washington for the Northwest Regional Commission. A high flight, B and W mosaic of U-2 photography and ERTS imagery were used to compile and present soil associations, geology, vegetation and land use data for a county in central Oregon to aid in land use planning. Several degrees of generalization of the data were developed at scales from 1:1,000,000 to 1:120,000. The photographic base is very effective for achieving user identity of the terrain features with the data presented. However, only a few copies can easily be made available. A planimetric base would probably be most appropriate to print maps for wider distribution. Land use classes have been mapped for the Willamette Valley using 1973 high-altitude true color photography. Changes in land use were studied using 1955 B and W high-altitude photos. Comparison of land use and soil patterns are being made.

Utah: The SCS and Forest Service are participating in a multi-discipline test site of remote sensing techniques along the Wasach Front in Salt Lake County, in cooperation with the McDonnell-Douglas Corporation. Data is from an aircraft-carried multispectral scanner flown at 6,000 feet altitude. Soils were mapped for an approximately 400 acre area by the SCS and grouped in seven general categories based on profile characteristics. Scanner data were computer classified by spectral signatures of ground truth samples. Comparison of the two maps show marked similarities. The SCS reported that when there is a soil-plant cover relation the sensed map will reflect a suitable map of soil patterns. Rock outcrop or coarse fragments for a given area also provide reflectance differences related to soil patterns. The SCS is working with a University of Utah graduate student to see if density slicing can help get a better relationship to the soil map.

Washington: The State Office of Community Development is cooperating with NASA and USGS on a statewide land use data system using computer classification of LANDSAT (ERTS) digital data. Print-outs are color coded and adjusted to a scale of 1:24,000. The products show promise for monitoring land use changes, but show little utility for soil surveys. [illegible], of Washington State University, has used high altitude and 4 inches = 1 mile B and W photos from 1974 and 1966 to assess land use changes in Whatcom County. No soil survey applications are planned. ERTS imagery was used as an aid in developing the state soil map for the Northwest Regional Commission, in cooperation with Oregon and Idaho.

Wyoming: A comparison of LANDSAT, Skylab, and high-altitude air photos for land use mapping in part of Crook County is reported in a special study. ERTS imagery has limited use for preparation of land use and soil maps. They require "ground truth" information to be utilized for interpreting soil patterns.

Additional Comments: The ASCS has obtained color infrared photos for Eddy County, North Dakota, and plans similar flights in 1976 for several counties in Wyoming. These appear to provide information to the viewer that would supplement B and W photos for soil survey work, and should be studied for that purpose. An additional set of photos for stereo analysis should be used in conjunction with orthophoto maps for field work. D. M. Carroll, Soils and Fertilizers, Vol. 36, No. 7, July 1973 and No. 8, August 1973, has an excellent summary article, "Remote Sensing Techniques and their Application to Soil Science." He concludes that for overall use in soil survey, panchromatic photography is generally the most useful. Color and color IR photography has advantages for specific areas and certain conditions. The Bureau of Reclamation has tested use of color IR and satellite multispectral scanner data but found application in their work.

Summary: The 1975 National Soil Survey Conference Proceedings, pp. 183-184, provides a national perspective of the status of remote sensing applications to soil survey. Good evaluations and cost-benefit comparisons with standard survey procedures are very few, according to this report. A previous summary and review for the Western Region is presented in the 1973 Regional Conference Proceedings. Most of the work to date has indicated most advantage in use of small scale ERTS imagery for obtaining a broad perspective and general soil map compilation or presentation. The few studies of the use of larger scale special color and color infrared photography, or multispectral scanner data suggest some potential for supplemental use in detailed soil surveys, but mostly are inconclusive, or results are not yet available.

Attention is directed to a recent publication:

Manual of Remote Sensing: Vol I - Theory, Instruments and Techniques; Vol. II Interpretation and Applications. American Society of Photogrammetry. 1975.

G. Evaluate Use of Over-flights for Soil Surveys

Over-flights are thought of in two different ways by people in soil survey. One is the use of aircraft for direct aerial observation of the survey area and for transport to selected points. The second is the use of secondary photo coverage of the survey area--generally high-flight photos, to supplement the larger-scale field sheets. Since comments were received on both usages of the term, they are evaluated separately below.

Use of Aircraft for Observations: The Forest Service probably has had the most extensive experience in using aircraft in soil survey operations. Helicopters are generally preferred because of greater flexibility in speed and availability of landing sites, although the cost is higher. They have been used in a number of areas with inaccessable terrain, both for obtaining an overview of the survey area, and for transport to specific locations for on-ground observations. Region 3 Forest Service soil scientists have used a helicopter to carry out the soil survey in one forest to reach remote areas of the survey. On many forests, soil surveyors fly as observers on the aerial fire surveillance program to familiarize themselves with landforms, vegetation, etc. Region 5 survey personnel have found over-flights very useful. The flights need to be well planned in advance. It seems to work best if only one thing is observed per flight; that is, one flight to observe landforms, one flight to observe vegetation, etc.

The SCS in California has tested use of light fixed wing observation flights in several survey areas. Reports by participants indicate: (1) over-flights are worthwhile, particularly of mountainous terrain and in initial and final stages of mapping; (2) flights should cover a limited size of area and restricted to a limited objective (kinds of observations); (3) careful preplanning of the flight is needed, so that observations test judgments made beforehand; (4) color and color IR 35 mm slide should be taken by one observer on the flight. Oblique and vertical transparencies obtained of whole flight lines were used in post-flight evaluations in California. Earlier work on techniques in use of 35 mm transparencies from over-flights in California was presented to Div. 5, SSSA, Tucson, AZ, Aug. 1970 by C. B. Coudey.

The SCS in Alaska relies almost exclusively on over-flights for small-scale and exploratory surveys, in determining landscape patterns and location of boundaries. It is likely that interpretation of high quality satellite or high flight imagery, when available, can replace actual observation. For detailed surveys, an initial over-flight may help to understand landscape relationships, but additional flights do not present any great advantage.

In Utah, the SCS used a helicopter to survey a remote area with a team of three soil scientists and a range conservationist. Sites were previously selected by photo interpretation. One soil scientist and the range conservationist were taken to the site. A representative pedon was located and the kinds and amounts of plants recorded. The other two soil scientists were flown to the site to finish the soil description, while the first soils man and the range man were flown to the next location. This proved to be a very effective and efficient way to survey remote areas. Over-flight observations were not a specific part of this survey, but were strongly recommended by the team members.

In northwestern New Mexico, a helicopter was used for three months this year by the SCS in making Order Three soil surveys. They estimate a cost saving of about 700%. They anticipate using helicopters for future broad-level surveys in inaccessible and low value areas.

The SCS in Arizona used over-flights in preparation of a general soil map of Coconino County. These resulted in speeding up the survey, observation of inaccessible areas, and a more accurate map. Another over-flight was for observation of landforms and geomorphic surface relationships to soils in the Yuma area. A single engine, fixed wing flight at about 2000' provided an overview of geomorphic relationships along the Colorado and Gila Rivers. A helicopter was used to fly over pre-selected portions of the area at about 200-250 feet, to observe geomorphic details and to make periodic stops for on-ground observations of soil characteristics. This seems to be an ideal way to gain perspective of an area under consideration for soil-geomorphic studies.

Use of Over-flight Photos: Comments on high-altitude photos were, in part, included under remote sensing applications (part A). Some additional comments follow. Small-scale high-altitude photography has been used routinely by the Forest Service and other improved efficiency and accuracy are likely to result.

Good, high resolution photography, flown at optimum times of the year should be obtained for soil surveys. Specifications for these flights should be determined by consulations with soil scientists. Orthophotos for survey areas should be of good quality or rejected. Stereophotos should be obtained for use with orthoplotes.

4. Training in airphoto interpretation, particularly in use of color and color IR imagery, is urgently needed for field soil scientists. Both basic training of beginning surveyors, and more advanced training at the party chief level are needed. Interagency cooperation in providing training is suggested.

5. Slope maps by USGS should be obtained and tested for many more areas. Where more than one agency has need for these, agreement on slope intervals and cost-sharing could make them more practical for use in soil surveys.

Committee 2 Members

Jerry Anderson	G. Hartington	G. H. Simonson-Chairman
R. Dierking	J. M. Richlen	F. C. Singleton
M. A. Fosberg	D. Richmond	D. Stelling
V. Link	R. Rieger	H. B. Waugh

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY
Phoenix, Arizona, February 9-13, 1976

Waste Disposal on Land
Committee 3

The following charges were given to the committee:

1. Assess the properties selected as

4. Assess experimental work now underway in region and prepare summary for Conference.

5. Develop guidelines for rating organic soils in the treatment of municipal waste water.

The discussion groups at the Conference had time to examine only charges 1, 2, and 5 in detail. No attention was given to the list of kinds of wastes being applied to land (charge 3) or to the research summary we had prepared (charge 4). The Conference was surprised that our survey showed some lack of agreement among soil scientists in the rating of soils for waste disposal (charge 1). There was general agreement that the guides for rating soils for waste [illegible] would split some soil series. Most agree that we should consider the effect of duripans and petrocalcic horizons separately from that of hardrock or bedrock.

Guide Sheet 4. Soil limitation ratings for sewage lagoons. Consideration of duripans and petrocalcic horizons separately from bedrock would improve our agreement using this guide sheet. There is a lack of understanding of the chemical reactions involved in waste disposal. Most agree that the committee's proposal for inclusion of soil reaction as a criterion would improve interpretations.

Guide Sheet 7. Soil limitation ratings for trench-type sanitary landfills. Most agree that the soil texture item needs improvement. The suggestions could best be followed by modifying the present lists of textures for slight and moderate limitations by adding "and gravelly and cobbly modifiers of the texture classes" to the first and "very cobbly modifiers of the texture classes" to the second. Most accepted soil reaction as an important criterion.

Guide Sheet 8. Soil limitation ratings for area-type sanitary landfills. Most accept the addition of soil reaction as a criterion.

Preconference Report Updated to Include Conference Recommendations

Charge 1. We distributed data and descriptions for the following soils: Acana, Astoria, Gila, Laveen, Lihue, Lucky Star, Ramona, and Sites. Agreement among soil scientists on the ratings was about 75%, i.e. 75% agreement on ratings for septic tank absorption fields, 88% for sewage lagoons, 634 for trench-type sanitary landfills, and 75% for area type sanitary landfills.

Charge 2. We think modification of some of the guide criteria, especially those for permeability, texture, and those involving hardpans, will improve the ratings and give better agreement. The following guide sheets have been modified to improve the accuracy of the interpretations and to increase the agreement among soil scientists on the ratings. 'In order to conserve space, only new items or items which were modified have been listed.

Guide Sheet 3.--Soil limitation ratings for septic tank absorption fields *

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to hard rock, 4/ or bedrock	More than 72 in.	48-72 in.	Less than 48 in.
Indurated duripan or petrocalcic horizon if within 40 in.	Less than 2 in. thick	2-4 in. thick	More than 4 in. thick
Cemented duripan or petrocalcic horizon if within 40 in.		Strongly cemented, less than 6 in. thick	Strongly cemented, more than 6 in. thick

* Guide does not include the effect of soil reaction on corrosion of the septic tank.

Guide Sheet 4.--Soil limitation ratings for sewage lagoons

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to indurated duripan or petrocalcic horizon	More than 30 in. deep, thicker than 4 in.	More than 30 in. deep, 2 to 4 in. thick	Less than 30 in. deep or less than 2 in. thick
Depth to strongly cemented duripan or petrocalcic horizon	More than 60 in.	40-60 in.	Less than 40 in.

Guide Sheet 7.--Soil limitation ratings for trench-type sanitary landfills 1/

Item affecting use	Degree of soil limitation		
	Slight 2/	Moderate 2/	Severe
Soil texture 5/ (dominant to a depth of 66 in.)	Sandy loam*, loam*, silt loam*, sandy clay loam*	Silty clay loam**, clay loam**, sandy clay**, loamy sand**	Silty clay, clay, muck, peat, gravel, sand
Depth to hard*** bedrock	More than 72 in.	More than 72 in.	72 in. or less
Total thickness of indurated duripan or petrocalcic horizon	Less than 2 in.	2-4 in.	More than 4 in.

* Include gravelly and cobbly modifiers with these texture classes.
** Include very gravelly and very cobbly modifiers with these texture classes, soils high in expansive clays may need to be given a limitation rating of severe.
*** On site investigations are needed to find if the rock is rippable.

Guide Sheet 8.--Soil limitation ratings for area-type sanitary landfills

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Soil reaction *	pH 5.5-8.2	pH 3.5-5.5, 8.2-9.5	pH <3.5 Oh >9.5

* Reflects the effect of the soil reaction on rate of decomposition, possible contamination, and plant growth.

Guide Sheet 9.--Suitability ratings of soils as sources of cover material for area-type sanitary landfills

Item affecting use	Degree of soil suitability		
	Good	Fair	Poor
Texture 1/	Sandy loam*, loam*, silt loam*, sandy clay loam*	Silty clay loam**, clay loam**, sandy clay**, loamy sand**	Silty clay, clay, muck, peat, sand, gravel
Cobbly and stony percent by volume	Less than 15 pct.	15-35 pct.	More than 35 pct.
Soil reaction***	pH 5.5-8.2	pH 3.5-5.5 or 8.2-9.5	pH <3.5 or >9.5

* Includes gravelly and cobbly modifiers with these texture classes.
** Includes very gravelly and very cobbly modifiers with these texture classes.
*** Reflects the effect of the soil reaction on rate of decomposition and plant growth.

Charge 3.

A. Kinds of waste

1. Refuse
   a. Sanitary landfills (municipal trash and garbage)
   b. Crop residue
   c. Forest residue
2. Animal wastes
3. Sewage
   a. Sewage treatment plant sludge
   b. Sewage effluent
4. Mine spoil
5. Food processing plant wastes
6. Fiber processing plant wastes
7. Industrial wastes
   a. Acids and alkalies
   b. Trace elements
   c. Organic compounds
8. Agriculture chemicals

B. Guidelines needed

1. Mine spoil
2. Food processing plant wastes
3. Fiber processing plant wastes
4.

D. Recommendation

Crops respond less well to animal waste applications in cooler climates and leaching losses of nitrate-nitrogen tend to he greater. In Nevada, because of potential leaching losses of nitrate-nitrogen, the experiment station now recommends that only enough animal wastes be applied to supply current crop needs. Crop needs in many of the Mollisols and mollic subgroups of other orders in mesic and frigid environments may be met by animal waste applications of about 10 to 25 T/A (University of Wyoming). Crop yield increases are gotten for application rates 5 to 10 times higher in Aridisols in thermic and hyperthermic environments.

Decomposition rates of animal waste can be measured in the laboratory or in the field. Rates are mainly dependent upon soil temperature and moisture but are not affected by loading rates (University of Idaho). Land spreading is now the most economical way to dispose of animal wastes. Other ways of waste disposal are being studied. Direct combustion is more efficient from an energy standpoint than is conversion to methane. Hydroxidation because of environmental reasons may be an alternative for the small feedlot operator (less than 100 head of feeder cattle). Animal wastes contain as much as 340 mg protein per gram of dry weight. About 67% of this protein can be extracted by 0.1 N NaOH. Only 54% of this can be recovered. Most of the protein is in the particles less than 250 mm and almost half is in living bacteria (Colorado State University).

Research on use of soils as disposal sites for sewage are also producing worthwhile conclusions. The equivalent of a 30-year treatment of 10 tons of municipal and industrial sewage sludge/A/year was applied to a loam to clay loam Fluvent to test the effect of the possible buildup of trace elements on crop growth and quality. In the three year period of the study no trace element toxicities were detected in the plants. The contents of trace elements in the plant tissue fall within the upper part of the biological range (University of California at Berkeley). Sewage sludge studies on wood waste mixtures of wood (50%) and sludge (50%); bark (25%) and sludge (s); wood bark (25%) and sludge (75") at 100 T/A gave the greatest plant growth.

Cadmium is one of the heavy metals receiving the most attention. Rice grown under paddy management suffered little or no toxicity for cadmium treatments of as much as 640 ug Cd/gm of soil. The Cd was added to sewage sludge and then the amended sludge to soil at a rate of 1%. The wet soil immobilizes the Cd by precipitating it as CdS. Following drainage, however, the Cd again becomes soluble and toxic. Under upland management Cd was highly toxic. A 25% yield reduction occurred where the treatment level of Cd was 17 ug Cd/g or greater (University of California at Riverside).

Pathogenic human enteric viruses can survive the method of secondary wastewater treatment employed at the Mililani plant in Hawaii even after chlorination. The test soils in a lysimeter study are highly effective in removing viruses from the wastewater (University of Hawaii).

The proposed future research on waste disposal involves determining toxicity levels of individual trace elements in plants and soils, testing model land disposal systems for municipal and industrial wastes, study of the nitrogen and phosphorus cycles, and monitoring of model basins or watersheds for pollution. The recent research has shown that phosphorus in animal manures has greater plant availability than that in inorganic fertilizers in calcareous soils. It has also shown the high correlation between low soil hydraulic conductivity and losses of nitrate-nitrogen through nitrate reduction and the influence of soil texture upon leaching losses of nitrate. Poisoning of soils through long-time additions of industrial wastes containing heavy metals does not seem as much a problem as we first thought. Special cases will doubtless develop in soils, however, in which industrial wastes with unusually high concentrations of one or more trace elements will build up to toxic levels.

Charge 5. Organic soils are expected to be less suitable for use as a media for the treatment of municipal waste disposal than most mineral soils and should be used as a "last resort." If it is necessary to use organic soils far the treatment of wastewater, then Saprists should be rated above Fibrists, soils in thermic families over soils in cryic families, and calcareous soils over strongly acid soils. Based on these principles, a guide for use of Histosols has been proposed for further testing.

Guide Sheet 1[illegible].--Limitation ratings for septic tank absorption fields in Histosols.

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Bulk density	More than 0.2 g/cc	0.1 to 0.2 g/cc	Less than 0.1 g/cc
Fiber content (rubbed)	Less than 1/6 volume	1/6 to 2/3 volume	More than 2/3 volume
Permeability class of limiting strata 1/	Rapid, moderately rapid	Moderate	Moderately slow and slow
Depth to water table 2/	More than 72 in.	48-72 in.	Less than 48 in.
Flooding	None	Rare	Occasional or frequent
Depth to hard rock, bedrock, or other impervious materials	More than 72 in.	51-72 in.	Less than 51 in.
Soil temperature	Greater than 15° C (59° F.)	8 to 15° C (47 to 59° F.)	Less than 8° C (47° F.)
Soil reaction 3/	Soil pH greater than 5.5	Soil pH 3.5 to 5.5	Soil pH <3.5

1/ The included mineral layers control the permeability of most Histosols.
2/ Depth of water table maintained by tiling or other methods of drainage.
3/ Reaction of the soil following drainage.

Committee 3 - Waste Disposal on Land

Chairperson: W. D. Nettleton

Members:

J. Allen
O. F. Bailey
D. M. Hendricks
T. B. Hutchings
H. Ikawa
J. Jay
D. Jones
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M. Openshaw
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WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE
COOPERATIVE SOIL SURVEY COMMITTEE REPORT

Water Relations in Soils
Committee 4

The following charges were given to the committee:

Assess application of hydrological models used by ARS and EPA pertaining to agricultural land.

Charge 1 - List soil and landscape properties required for these models. Indicate those not available from order 2 or 3 soil surveys.

Charge 2 - How can properties needed but not now available be obtained?

Examine the application of ARS hydrological model USDAHL-74 and EPA Agricultural Chemical Transport Model (ACTMO) in the soil survey.

Charge 3 - Can soil moisture patterns be predicted more accurately by use of one of these models?

Charge 4 - Should application of HL-74 be considered for application in taxonomic soil moisture regimes?

Charge 5 - Assess application of HL-74 in the region to predict change of streamflow and overland flow resulting from change in land use on a watershed.

Charge 6 - Review definitions and criteria related to soil-water relations in the draft of the Soil Survey Manual.

General Background and Comments:

There are currently two hydrologic models in use by ARS and EPA in determining runoff, sediment yield, and chemical movement from watersheds. These are the USDAHL-74 Revised Model of Watershed Hydrology and the ACTMO, Agricultural Chemical Transport Model. These models are still in the development stages, having been revised and updated several times as the need has been discovered from use. An advisory group of SCS and ARS personnel have the charge of reviewing these models for application in SCS work and possible needed changes. Other models are in the development stages. The Stanford Watershed Model (not included in this review) is being used by a wide variety of agencies. It has the same basic model capabilities as USDAHL-74 but uses Horton's infiltration equation rather than Holtan's equation used in the ARS model.

The USDAHL-74 model is a basic hydrologic model used to develop runoff hydrographs at various locations. This model is the hydrologic component of the ACTMO model. It produces hydrographs used in evaluating the movement of sediment and chemicals of the Chemical Transport Model; therefore, the basic input data needed and the general application to soil moisture conditions are the same for both models.

The basic relationship solved by the USDAHL-74 model is runoff equals rainfall minus initial abstraction and infiltration. Rainfall patterns and amounts are generated from National Weather Service data. Determining infiltration is the major portion of the problem solving process of the program.

Infiltration as determined by Holtan's equation is a function of vegetative cover parameters, vegetative growth indexes, available storage in the surface layer, and the final infiltration capacity. Cracking of the soil and ponding of water in surface depressions are also taken into account. These items must be developed for each zone having different soil and landscape features in the watershed. Since the amount of moisture to fill the surface layer is considered, the soil moisture at any time must be known or computed. A complete accounting is made of all moisture including moisture involved in filling the profile and infiltrating after the soil profile is saturated.

Answers to Specific Charges

Charge 1 – List the soil and landscape properties required for these models. Indicate those not available from order 2 or 3 soil surveys.

Response – The models were specifically set up to use landscape and soils data from soil survey reports. Most of these features can be obtained from soil survey reports and from maps or aerial photographs of the watershed. The following list of needed input data related to landscape and soils is taken directly from the model reports.

Number of crops------------ Total number of crops or land use practices (i.e., drilled and straight-row corn might be two crops)

Deep groundwater recharge, IN/HR--- ----- Deep percolation rate which does not show up in the recession curve.

Does land use change? Yes/No------------------- If any crop distribution percents within zone change during the period of the run, answer yes.

Does tillage change? Yes/No--------------- --- Is the tillage practice available yearly for each crop?

% [illegible]--- ------------ ----- Percent areal distribution of the soil types in the watershed.

Length FT.----------------- Average length of flow on the zone.

% Slope ------------------ Slope of the zone.

FC IN/HR------------------ Final rate of infiltration after prolonged wetting.

Topsoil IN.- ----------- Depth in inches of A horizon or topsoil.

Total soil IN.------------ Depth in inches of aerated, well-drained soil including topsoil.

% Gp_1 - --- ------------ Percent of topsoil depth drained by gravity. 0.0 to 0.3 bar.

% AWC_1----- ------------- Percent of topsoil depth drained by plants. 0.3 to 15 bar.

% ASM_1--------- --------- Percent of topsoil depth holding water at the beginning of calculation period.

% Cracking--------------- Percent of topsoil depth subject to cracking.

% Gp_2, % AWC_2,
% ASM_2,
% Cracking--------------- Same as above except referring to the soil profile below the topsoil.

Crop name------------------ Name of each crop.

A Values------------------- Basal area of vegetation used as an index of surface connected porosity.

HU IN--------------------- Volume of depressions that would store rainfall until it infiltrated.

Root depth IN.------------ Root depth.

Till ---------------------- One of the four tillage codes.

MMDDYY------------------- Date of the tillage practice. Two dates for the same crop may not be in the same week. Month, Day, Year.

[illegible] Crop ---- ---------- - Percent of the zone in the crop. The sum of the percents for a given zone must equal 100.

[illegible] ---------------- Consecutive weekly averages of daily pan evaporation.

Of these items, the following are usually contained in an order 1 soil survey. Most order 2 and 3 soil surveys would supply these data or estimates of them:

1. The pattern and extent of soils with different water relations in a given tract such as a watershed.

2. The slope gradients, land forms, and parent materials.

3. Soil profile properties by significant horizons including:

   a. Thickness of horizons
   b. Texture
   c. Permeability
   d. Available water holding capacity
   e. Bulk density (available only by estimating from qualatative descriptions in some surveys)
   f. Impeding layers - hardpans, claypans, etc.
   g. Percent of various horizons that are subject to cracking

4. Depth to water table when within 60 inches.

5. Depth of aerated, well-drained soil when within 60 inches.

6. Rooting depth.

7. Erodibility.

8. Hydrologic soil group.

In some instances legends would have to be modified and adjustments made in field operations to obtain all of these data or to make the interpretations to provide them in surveys of order 3 or higher. These data would most likely be available on only the extensive or dominant soils. Actual laboratory data would be limited or not available; but estimates by informed and experienced field soil scientists could provide useful empirical information.

Basically, considerable judgement must be applied to data from soil surveys in providing input values for the models as this data is expressed in qualitative terms or in ranges having considerable variation. The accuracy of the computer analysis is often lost in the lack of preciseness and inaccuracies of the soil and landscape data.

The following items are generally not available from soil surveys.

1. Final infiltration capacity except in some bench-mark soils.

2. Deep percolation rate.

3. Depth of aerated, well-drained soil below 60 inches.

4. All of the vegetative, tillage, and other land use information, as these items, are subject to yearly change.

5. Class A pan evaporation, except in those cases where irrigation guides have been developed. (This may be considered a climatological variable, rather than a landscape feature.)

Charge 2 - How can properties needed, but not now available, be obtained?

Response - Most of the soil and landscape features are supplied by soil survey as the models were specifically written for this. Model users generally would like to have more precise values than soil survey can realistically provide where quantitative values are needed. These items and those not directly available are estimated or interpolated from soil survey data or irrigation guide information.

Cropping patterns, tillage changes, volume of depressions, deep percolation rate, final infiltration capacity, and pan evaporation are not directly available from soil survey. These items can usually be obtained from other sources or estimated. It is not recommended that soil survey be changed or expanded to include more information for these models as all data within the practical consideration of soil survey is now included.

Charge 3 - Can soil moisture patterns be predicted more accurately by use of one of these models?

Response - These models have a complete soil moisture accounting system. The system requires a soil moisture content at the starting point, then accounts for all soil moisture through wet and dry rainfall patterns as generated from National Weather Service data. This accounting can generally be projected over long periods and should give more accurate results of soil moisture conditions than those presently used.

Some problems have been reported in semiarid regions and under snowmelt conditions. Frozen ground conditions may also cause some inaccuracies.

Paper No. 75015 of the Water Resources Bulletin; SOIL MOISTURE ACCOUNTING COMPONENT OF THE USDAHL-74 MODEL OF WATERSHED HYDROLOGY, by C. B. England[1/], reports on a soil moisture study using hydrologic models made near Chickasha, Oklahoma. After adjusting root depth parameters, the study showed very close correlation of computed soil moisture using the model and comparing to actual soil moisture measurements. The author concludes that the capability of the model to simulate soil moisture has been established and that the model can provide a framework for incorporating new data concepts in accounting for water in watersheds.

Charge 4 - Should application of HL-74 be considered for application in taxonomic soil moisture regimes?

Response - The amount of soil moisture occurring in a soil moisture control section is a necessary consideration for placing soils in the Soil Taxonomy. Measurements should be made throughout the year and over long periods of time to be significant for soil classification.

There are few, if any, soils that have data meeting the above requirements. Therefore, the type of information needed for appraising a soil moisture regime has been calculated from meteorological or climatological records. Numerous investigators have developed empirical methods for estimating the "water balance" that occurs in soils, mainly for climate, watershed hydrology, or irrigation planning and scheduling. Some of the studies for irrigation have been thorough but generally apply only to the season of use.

The more sophisticated methods use a fairly complete array of meteorological measurements and others use mean monthly precipitation and mean monthly temperature. In addition to using meteorological measurements, some methods evaluate various site parameters such as slope gradient, aspect, vegetative cover, elevation, and others. Jen-Hu Chang discusses some of the methods in his book Climate and Agriculture.

The national committee considered in some detail the USDAHL-74 hydrologic model and its application in predicting soil moisture patterns and use in estimating placement of soils in taxonomic moisture regime classes. The committee report appears encouraging and suggests further testing and comparing with other systems and methods.

This committee looked into the use of this model in predicting soil moisture for use in establishing soil moisture regimes. There are differing opinions on whether it should be used. Some have the opinion that future committees should look into the work done by Klaus Flach to see if the model work would merely duplicate these same efforts. Others would like to have future committees look into using just the

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1/ Soil Scientist, Hydrograph Laboratory, Plant Physiology Institute, Northeastern Region, Agricultural Research Service, U.S. Dept. of Agriculture, Beltsville, Maryland 20705 effectiveness of soil moisture accounting for this work. The U.S. Forest Service has a model specifically for soil moisture accounting, "Soil Moisture Regime--REGIME." This model has been used to determine soil moisture regimes for mapping on National Forest lands. Further studies to determine its application in other areas is recommended.

Charge [illegible] - Assess application of HL-74 in the region to predict change of streamflow and overland flow resulting from change in land use on a watershed.

Response - The purpose of the HL-74 model is to predict change of streamflow resulting from change in land use. The answer to this charge cannot be given until the model has been proven by use. The mathematical limitations of the model itself generally control the accuracy of the answer which is less accurate than the expected change in streamflow from changes in tillage or land use. This is generally the result of inaccurate assumptions and basic data.

This charge appears to be pointed toward investigating the hydrologic model on the basis of whether it will produce the intended results in predicting streamflow and runoff. This is an area that should be investigated by hydrologists and other engineers who develop this data. The committee recommends no future action by soil survey committees on this charge.

Several favorable reports were received of the models use with good and accurate results. Other reports are not as favorable. One such unfavorable report indicated poor results in predicting runoff in a watershed located in a semiarid region in the west. It has been suggested that there may be a problem in applying the model to snowmelt conditions and to areas having frozen ground.

Hydrologists explain that some watershed models are not effective in an area due to the random nature of thunderstorms and the limited number of precipitation gages. Hydrologists effectively use these models by calibrating them with actual data (precipitation and streamflow) then evaluate effects and trends for other probable occurrences. They are also used to define areas where additional research is needed or where better data is needed.

Charge [illegible] - Review definitions and criteria related to soil-water relations in the draft of the Soil Survey Manual.

Response - The only recommendation made on the soil-water relations definitions and criteria in the draft of the Soil Survey Manual deals with the term "perviousness." It is the consensus of the work planning conference to recommend the term "permeability" be retained instead of "perviousness" as included in the draft. The present terminology is well established in all fields and confusion will result from changing it.

Summary

Generally the input data dealing with soil and landscape features needed in hydrologic models are available in soil surveys. Judgement and estimates often must be made to soil survey data in providing quantitative input values for use in hydrologic models. Soil moisture accounting systems in the models will likely provide more accurate predictions of soil moisture patterns. There is some objection to changing the term "permeability" to "perviousness" in the definitions relating to soil-water relations found in the Soil Survey Manual.

Recommendations

It is recommended that committee work be continued, but future work be narrowed to one aspect such as determining how soil moisture accounting is accomplished in a given type of model and if it can be applied to taxonomic soil moisture regimes. Copies of the model development material should be supplied to the committee. The committee should be originated of or have several people who have a working knowledge of the model and can readily find the needed information such as ARS and EPA personnel. Consideration should be given to a study of the U.S. Forest Service REGIM3 program for water balance.

Committee Members:

J. R. Talbot, Chairman
W. K. Barju
T. B. Hutchings
D. Gollup
S. Brown
D. Dierking
R. Ikawa
L. Doughtery
G. A. Nielson
T. Collins
R. Gilberson

MEASURING, MAPPING AND MONITORING SOIL SALINITY IN IRRIGATED LANDS

J. D. Rhoades [1/]

As a Technical Advisor (Salinity) for the Agricultural Research Service of the United States Department of Agriculture, I have the responsibility to enlighten potential users of significant, new information and techniques from which they might benefit. I am also expected to point-out deficiencies in our information base and present capabilities. I feel that such a deficiency in our agricultural information base now exists and needs the attention of the soil survey community. The deficiency, of which I speak, is the lack of an adequate inventory of the extent and location of saline soils, or soils becoming salinized, in the United States. This information is lacking apparently for two reasons: 1) There is no organization in the U. S. having the specific responsibility to inventory and monitor soil salinity, and 2) Suitable techniques for measuring and mapping soil salinity have been lacking. As important as irrigated agriculture is to the economy and food productivity of the nation, it seems a great oversight that salinity, a major, common problem of irrigated lands, is not systematically inventoried by one of our federal resource agencies. The second reason, lack of a suitable technique, I think is now overcome. It is this latter matter that I mainly want to discuss with you today - a practical method for measuring, mapping and monitoring soil salinity.

Before I describe this method, let me first briefly comment on the adequacy of conventional methods for surveying and monitoring soil salinity. When soil salinity surveys are generally made, they are usually based on one of the following: 1) visual indications of excessive salts, 2) associations of mappable soil physical properties with salinity, 3) extrapolations of soil analyses made on a few soil samples taken from a model profile to other areas having apparent similar conditions, or 4) a limited number of on-site salinity appraisals using "four-electrode" techniques. Such methods are either not very meaningful or else not very practical for lands that are under cultivation and irrigation.

The crops being grown in any area are generally those best suited to the climatic conditions, soil properties, water quality, and market demands and outlets. For such crops, yield may be reduced 20 per cent, or more, without visual symptoms of salinity damage. Crops vary in salt tolerance; if only very tolerant crops are being grown, the presence of salinity levels harmful to more sensitive crops can be obscured. When the area to be mapped is not uniformly covered with a single crop, which is typical, the required base for mapping (a common reference plant) is absent. Such delineation based on visual crop appearance is further complicated by differences in fertility, disease, and water stress, etc., from field to field which may obscure or be confused with salinity. Surface deposits of salts may similarly be misleading because they may have accumulated there over a long period of time by capillary rise and evaporation of soil water that is not high in salinity. Further what may appear to be large deposits of salt may be only minor crusts. What may appear to be deposits of soluble salts may in fact be only deposits of calcium carbonate or gypsum that are not sufficiently soluble to depress crop yield. Surface deposits of more soluble salts, especially if they have accumulated in bed ridges from furrow irrigation processes, are seldom harmful to established crops since the roots are not functioning in this salt. Obviously, visual appearances are deficient for inventorying salinity.

Natural or inherent salinity patterns associated with mappable soil units are probably less related to soil properties, per se, than to physiographic position, proximity to water tables, or drainage restrictions during the time of soil formation. With cultivation, irrigation and installation of drainage facilities, such associations are frequently altered. In most cultivated, irrigated lands, salinity is more likely associated with the quality of the water used for irrigation, the depth of the water table, and management practices - especially irrigation management. Soil properties may alter these associations but seldom are dominant.

Since salinity is not well associated with crop or soil appearances or properties, a direct assessment of salinity is needed. Salinity is typically nonuniform. It varies with depth in the soil profile and from location-to-location within the field. This is especially true in irrigated lands because of the differences in water application and infiltration within fields and because alluvial soils are typically so variable. Such nonuniformity is further accentuated by the furrow method of irrigation, where only a part of the soil is irrigated (hence leached) and the ridges promote localized accumulations of salts. Because of these variations along with those associated with differences in management, quality of irrigation water, installation of drains, etc., a few soil samples collected from within a survey area to characterize and describe soil mapping units are not likely to give representative levels of soil salinity for that mapping unit, or even for that individual field.

For the above reasons, many measurements of soil salinity must be made. While "field kit" techniques can, in principle, be used, they are not very practical. Collecting samples for later laboratory analyses is not at all suited to survey work where decisions need to be made on the spot and at the time - not later. In either case, such conventional methods are very time consuming and expensive when done in sufficient numbers to properly determine the levels of salinity representative of the areas under consideration, especially when repeated determinations are made to follow salinity changes with time. It is these demands of time, manpower and finances that have limited the availability of good salinity surveys or inventories. A less restrictive method of salinity measurement is needed to overcome these limitations.

Today, I'll describe a method for measuring, mapping, and monitoring soil salinity and proximity of shallow water tables that reduces the above limitations considerably. The method is simple in concept and operation; it is rapid and inexpensive. It is particularly well suited to field use and mapping. It eliminates the need for taking soil samples and making laboratory analyses. The method involves the measurement of the resistance of the soil to electrical current in situ without removal or disturbance of the soil. I first advanced the method and demonstrated its merits in a publication in 1971. Since then the technique has been extensively tested and refinements have been made. In addition new devices have been developed to further expedite the measurements. I believe that you can use this method to great advantage in surveying soil salinity or land under the influence of a shallow water table.

Before I discuss the details of the method let me first reiterate to you my concern that no agency is now monitoring soil salinity in our irrigated lands. In a few projects, salt balance evaluations are being made - but they are absolutely inadequate as a suitable criterion for assessing the adequacy of leaching and drainage practices or facilities for salinity control of irrigated lands (1, 2). Projecting present trends and needs into the future, one can easily envision the increased need for adequate salinity inventorying and monitoring programs. There will be more competition for the water now used for irrigation, and water now used for leaching will be diminished; simultaneously there will probably be restrictions placed on the discharge of salt from irrigation projects. With less leaching, and salt discharge from irrigated lands, there will be a corresponding increase in soil salinity. Some salinity increase can be tolerated without yield reductions with the adoption of new irrigation practices, but excessive accumulations must be avoided. Guesswork cannot be tolerated in this regard if an *efficient and productive* form of irrigation agriculture is to be achieved. Direct monitoring and inventorying will be required. Someone (agency) must assume this responsibility. I hope that you can help in this task - evaluate the methods I'll now describe to you and help get them into effect.

The principles, equipment needs, methods, and applications of the four-electrode method were then discussed. The applications discussed were: 1) measuring bulk or average soil salinity, 2) measuring soil salinity within discrete depth intervals, 3) mapping soil salinity, 4) detecting a shallow, saline water table, 5) determining leaching fraction, and 7) monitoring changes in soil salinity. A manuscript describing the technique was passed out (3).

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3. Rhoades, J. D. 1976. Measuring, Mapping and Monitoring Field Salinity and Water Table Depths with Soil Resistance Measurements. Proc., Expert Consultation on Prognosis of Salinity and Alkalinity, Rome, Italy, June, 1975. (In press).

1/ Soil Scientist, ARS Salinity Laboratory, Riverside, California

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Recommendations of the committee are as follows:

1. The states should be contacted and asked to identify which soil survey areas should include a bound general soil map or a general soil map printed on one map sheet at a scale of 1:100,000 placed in a jacket in the report. Normally, bound general soil maps should continue to be a part of the published report. If a state has a special need for large scale 1:100,000 base maps in addition to the bound general soil map, this should be stated in a letter to the cartographic unit.

2. Using the lists provided by the states as described above, the states should be provided with cost estimates and related information for soil survey areas on the soil survey publication for each fiscal year. The data should be furnished by the Washington Office to the states annually, after the publication schedule is established. This would include: (a) number of map sheets at 1:100,000 scale for the survey area; (b) size of the map sheet; (c) estimated cost to the state; (d) availability date to state for use as a base map for compilation.

This information will enable the states to decide whether they want to develop a more detailed general soil map at 1:100,000 scale for multipurpose use compatible with the LIM program.

3. A sample map prepared from the USGS base map at 1:100,000 scale should be prepared by our Washington Office and furnished to states for information purposes. This map should depict the map detail as it will normally appear for SCS maps utilizing the USGS base map.

[illegible]

the 1:100,000 maps will be. This may be a determining factor in whether a state wants to cost-share for preparing the 1:100,000 scale maps from USGS.

5. With respect to Charge No. 3, it was agreed by the committee, and approved by the conference members, that a development of models of mapping units, with special attention given to discussing general land use and potential, has been covered by Committee No. 7 in their handling of Charge No. 1.

COMMITTEE 6

SOIL AND SOIL MATERIAL DISTURBED BY MINING

To Charge 1: Classification of soils on mine spoils

A. React to the proposal in the 1975 National Soil Survey Conference Report that a suborder of Spolents be established for highly disturbed soils. (Report of the Committee on Classification of Soils Resulting from Mining Operations and the Interpretations.)

The Western Soil Survey Conference recommended that Spolent Suborder is not needed. This reiterates the Conference position on this subject in 1974.

B. Assess the feasibility of setting a limit between Orthents (or Spolents) and Arents at 20 percent by volume of fragments of diagnostic horizons in the 10 to 40 inch section. Would other limits be better?

The Conference did not recommend any changes in the limits of 20% by volume of fragments of diagnostic horizons in separating Orthents and Arents.

C. Develop criteria for Fluvents and Fluventic subgroups that would exclude soils in mine spoils that have an irregular distribution of organic carbon with depth.

The Conference recommended that a committee be retained to develop criteria which would exclude mine spoils, which have an irregular distribution of organic carbon with depth, from (Fluvents) and (Fluventic) subgroups. These changes should be introduced at the appropriate time after Soil Taxonomy is published.

Charge 2. Develop criteria for interpreting soils for the optional use and treatment of land affected by mining operations.

A. Develop guide for rating soil material for use as final cover for mined land.

This charge is premature but ratings for final cover for sanitary landfill and mine spoils should have many of the same criteria; therefore, these should be developed simultaneously and by the same committee.

B. Results of investigations of special problems encountered in soils on mine spoils should be assembled for guidance in making interpretations.

Data from Colorado and Utah appear to point out most of the problems. The following items were used by the committee to summarize the findings for the Conference:

(Adapted from TAES Bul. 465) Mine spoils are highly variable in physical and chemical characteristics. The variability is influenced by kinds of mining operations, variations in the ore body, the amount of toxic substances present and the age and exposure of the spoils. Where excess salts are present at least a portion of these salts must be removed by leaching, either by precipitation or irrigation or both if drainage is adequate. The oxidation of sulfides can lead to an acidification of tailings, and heavy metal toxicity. When pH values of spoils are less than 6, plants grow poorly. Liming can prevent the problems associated with low pH. Rates of liming required can be determined by assessing the acidifying potential of the sulfides present in the spoils.

Spoils are generally deficient in plant nutrients, nitrogen and phosphorus are required on most sites. These can be supplied with commercial fertilizer. Minor element imbalances often tend to be aggravated where barnyard manure is used as a fertilizer.

Wind erosion may be severe on spoil banks and "sand blasting" can seriously damage plants in a short period of time. Erosion must be controlled while plants are becoming established. Chemical binding agents and/or mechanical barriers may be necessary to protect the surfaces. Irrigation is required on many sites during plant establishment and on some sites indefinitely depending on amount of patterns of precipitation.

c. A number of the cooperators in the NCSS are presently involved in making guidelines for reclamation of mine spoils. There appears to be little or no coordination among the agencies. Assemble a summary of available guidelines in a form that may be used as a guide for developing general standards for all cooperators.

Guides are as yet not available but research data from Colorado, Montana, New Mexico, North Dakota, Utah and Wyoming were examined and in general the following are guidelines relative to the criteria needed to rate mine spoils and cover for sanitary landfills. (Adapted from NMAES Ref. 294):

Soil chemical, physical and mineralogical properties which describe plant nutrient availability, presence of toxic element concentrations and salts, permeability of soil material to air and water amounts of machinery and erosion hazard.

The conference recommended that this committee be retained.

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Chairperson: A. R. Southard

Members

[illegible]	[illegible]	L. Daugherty	J. Owen Carleton
[illegible]	L. Keifer	[illegible]	J. Stroehlein
[illegible]	G. A. Nielsen	K. Larsen	

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Soil Interpretations
Committee 7

SYNOPSIS OF CHARGES TO THE COMMITTEE and
Committee Recommendations to the Conference

Charge 1. Prepare models of soil interpretations that can be made for order 3, 4 and 5 soil surveys.

The committee and the discussion groups agree that adequate models and examples of the use of these models of soil interpretations are available.

There seems to be general concern about misunderstanding on the part of our customers as to the reliability of interpretations made for order 3, 4 and 5 soil surveys.

1. The committee recommends that a more detailed "How the soil survey was made" section be prepared, more thoroughly describing field procedures, being more specific about sampling rates, and speaking specifically to the "statistical reliability" of soil maps and interpretations.

2. The committee recommends that more specific guidelines be prepared on the fabrication of interpretive maps for multi-taxa mapping units; or permit states wide latitude in the preparation of said maps, being subject to no review nor criticism at NSO or NTC level.

Charge 2. Expand the concept of SOIL POTENTIAL

1. The committee recommends that soil suitability, soil capability and soil potential be defined to be mutually exclusive.

2. The committee recommends that the model for and example of a map unit description for order 3, 4, and 5 soil surveys be accepted. This recommendation speaks adequately to Charge 3, Committee 2, pertaining to map unit descriptions.

The committee agrees to amend the statement in the pre-conference report pertaining to soil potential to read as follows:
"SOIL POTENTIAL is related to the suitability of a soil for a specified use after the limitations that affect said use have been overcome."

Charge 3. Prepare interpretation guides for organic soils using as an example the guides prepared in the northcentral and northeastern states.

The committee recommends that subject guides presented at and printed in the proceedings of the 1975 National Soil Survey Conference be field tested.

Charge 4. Evaluate procedure now used for obtaining crop yield potential.

The committee recommends that the conference request prompt delivery of guides to be prepared by a task force that was recently appointed to study procedures used for obtaining crop yield potential.

The report of the committee was approved and accepted by the conference membership.

T. Holder, Chairman	D. Jones
F. Peterson	W. Singleton
G. Kennedy	J. Douglass
B. Seay	N. Openshaw
L. Lawson	M. Miller
R. Huff	O. Haije
C. Bailey	J. Anderson

MATERIAL PRESENTED TO CONFERENCE DISCUSSION GROUPS
by Committee 7 - SOIL INTERPRETATIONS

Charge 1. Prepare models of soil interpretations that can be made for order 3, 4 and 5 soil surveys.

The committee began to be confused at the charge. The question was interpreted by most to ask for methods of display of interpretive data.

The kinds of interpretations that can be made depends on:

1. The number and distribution of the points of reference; or the reliability of ground truth collected.

2. The scale of base map - limiting the size of area that can be shown.

3. Kind (single or multiple features) of interpretive maps, and complexity of other display materials, e.g., tables, charts, narrative, etc.

To insure our agreement as to the level of detail, a portion of the table "Criteria For Identifying Kinds of Soil Surveys" from the 1975 NCSS conference was reproduced and presented to conference members.

At these levels of generalization can we do more or less than make general ratings as to SUITABILITY or POTENTIAL for uses as follows:

AGRICULTURAL
Cropland - nonirrigated and/or irrigated
Grazing Land - native (range) and pasture
Forest - wood products

NON-AGRICULTURAL
Housing - Subdivision Development and Single (Isolated) Dwellings
Industrial -
Trafficways
Recreation
Watershed

There are numerous possible models of ways to display the interpretations, probably the most comprehensive, and perhaps confusing is the SCS-Form 5 that can be used for any kind of soil mapping unit, and further used to ultimately generate a tabular presentation to enable the comparison of numerous map units.

The matter of how much descriptive information to present about the map units is subject to continuing debate, as is the matter of giving reasons for specific ratings for various uses.

The committee feels that adequate models are available - the problem, which will differ with each set of circumstances, is to choose one, modify it where necessary and proceed.

Development of criteria for interpretations for the subject kinds of soil surveys seems to the committee to warrant no more than a restatement of the criteria currently used and currently being revised for making all kinds of soil survey interpretations. Briefly listed as follows these are:

SOIL FEATURES: Depth, texture, consistency, drainage, permeability, volume of coarse fragments, slope, aspect, and toxic amounts of elements, or deficiencies of elements.

CLIMATIC FACTORS: Precipitation - amount and distribution, length of growing season, wind velocity, etc.

SOCIO-ECONOMIC FACTORS: Cost, relative desirability, nuisance factors, etc.

MODEL

FOR MAP UNIT DESCRIPTIONS

FOR ORDER 3, 4, & 5 SOIL SURVEYS

Number and Name of Map Unit (from map)

Paragraph 1. General Statement
Location in state
Topographic statement
Slope classes and landform
Materials from which soils developed

Paragraph 2. Setting
Elevation - rounded to 500 feet
Percent of slopes (range) rounded to 5 or 10 percent
Mean annual precipitation rounded to 5 inches
Mean annual temperature rounded to 5° F.
Frost free season rounded to 25 days
Total acreage in 10,000's and total square miles rounded to hundreds

Paragraph 3. Percentage of named map units and inclusions rounded to 5 percent

Paragraph 4. Description of each named map unit
Soil depth - shallow, mod. deep, deep
Soil color - dark, light
Soil drainage - poorly, somewhat poorly, well
Soil texture (sandy, loamy, clayey)
Soil coarse fragments - kinds and amount
Slope (descriptive and percent)
Physiographic position (alluvial fans, hills, etc.)
Depth to bedrock - less than 20", 20 to 40", more than 60"
Depth to seasonal high water table - range in feet
Flooding potential (if applicable - frequency and duration classes)
Shrink-swell potential
Frost action potential
Reaction of soil - range of classes

Paragraph 5. (Forestry, recreation, cropland, etc.)
Ownership - Federal, State, Private, Indian)
Native vegetation
(Trees - grass) Major species

Paragraph 6. Major limitations in use
(Cold, dry, rocks)
Potential of development

EXAMPLE MAP UNIT DESCRIPTION

4 PSAMMENTIC EUTROBORALFS, loamy - ARIDIC HAPLOBOROLLS, loamy; gently sloping and sloping

This map unit comprises the Black Forest area of southern Douglas and Elbert counties and northern El Paso county. The soils in this association occupy the South Platte-Arkansas divide of the foothills and soils are formed in materials weathered residually or locally transported from arkose beds.

Elevations range from 6,500 to 7,500 feet. Slopes range from 0 to 25 percent but are commonly less than 15 percent. The mean annual precipitation is about 20 inches. The mean annual soil temperature is about 45° F. and the frost free season is about 100 to 125 days. This map unit covers about 190,000 acres. (300 square miles)

Psammentic Eutroboralfs make up about 35 percent of this map unit, and Aridic Haploborolls about 25 percent. Included in this map unit are other similar soils, and small areas of soils which are less than 20 inches to bedrock.

Psammentic Eutroboralfs: These deep, light colored, well drained soils have sandy surface layers and loamy subsoils and are on gently sloping to sloping areas of alluvial fans, and on sideslopes and crests of hills. Slopes range from 5 to 25 percent. Depth to bedrock is more than 60 inches and depth to seasonal high water table is more than 6 feet. They have rapid permeability, and a low shrink-swell and frost action potential. They are strongly acid to neutral in reaction.

Aridic Haploborolls: These deep, dark colored, well drained soils have sandy or loamy surface layers, loamy subsoils and are on gently to moderately sloping areas. They formed in arkosic sandy loam sediments on uplands. Slopes range from 0 to 15 percent. Depth to bedrock is more than 60 inches and seasonal high water table is greater than 6 feet. They have moderately rapid permeability and a low shrink-swell and frost action potential. They are typically neutral in reaction.

This map unit is used principally for range land, and home site development. There is some woodland harvest, recreation development and non-irrigated cropland. The native vegetation is predominantly Ponderosa pine with open areas of grasses composed mainly of bluestems, prairie sandreed, mountain muhly, blue grama, Junegrass and wheatgrasses.

The cold climate and limited rainfall are the major limitations to the use of these soils for cropland. The potential for development of homesites and recreation areas is good.

Factors limiting the potential of these areas for development of home sites are limited rainfall, moderately sloping to hilly topography and sandy surface layers that result in moderate to high erosion hazards and moderate constraints on placement of septic tank absorption fields. These limitations can be overcome by: 1) construction of roads as nearly as possible on the contour, and reseeding disturbed areas; 2) restrict the size of graded areas to the minimum required; 3) select nearly level areas, or grade areas to nearly level for placement of absorption fields; reseed or sod disturbed areas with drouth-tolerant species of grasses and shrubs.

Charge 2. Expand concept of soil potential.

Some Observations on Soil Potential

Some confusion exists, or persists, concerning the difference between SOIL POTENTIAL and SOIL SUITABILITY. Some individuals who do not hesitate to make ratings of soils that speak to suitability are hesitant to rate soils in terms of potential. Others feel that we should not rate in terms of either SUITABILITY or POTENTIAL, but should record the facts about soil characteristics and qualities as they are observed, and let the users (decision makers) draw their own conclusions.

A pertinent question to the conference at this point might be "Will we continue to rate soils for various uses?" Presuming an affirmative answer, will the conference accept the following:

SOIL POTENTIAL is related to the suitability of a soil for a specified use after the limitations that affect said use have been overcome. This will inevitably lead to the discussion of the "pro and con" of our becoming involved in "standards and specifications" or design. Further objections will be raised concerning our becoming involved in economic evaluations in which most of us profess, or confess, to having no expertise.

To the specific items in this charge the following are offered:

a. Develop a list of kinds of soil potential needed.

Ratings of the SOIL POTENTIAL can be and should be made for all land uses for which we presently make soil suitability ratings, i.e., Sanitary Facilities; Community Development; Water Management; Recreation Development; Crop and Pasture Production; Woodland Production, Wildlife Area Development; and Range Production.

b. Improvement needed to achieve potential.

Several examples of approaches to reaching the potential are:

Range Production Potential: 1) installation of fences and livestock watering facilities to get distribution of grazing animals; 2) establish rotational grazing systems to allow vegetation to recover from grazing; 3) reseed areas where desirable species listed as potential vegetation have been destroyed.

Crop Production Potential: The erosion hazard limiting the crop production potential can be overcome by 1) construction of diversion terraces to reduce control damaging inflow of water; 2) construction of level, parallel terraces to reduce to steepness and length of slopes; and construction of grassed waterways to function as emergency spillways for terrace systems.

Community Development Potential: The area will have good potential for community development by installation of intercepting dikes and tile drainage systems to reduce wetness.

c. Model for Map Unit Descriptions

On the following pages are: 1) a model for Map Unit Descriptions for Order 3, 4 and 5 Soil Surveys; and 2) an example of such a map unit description.

Charge 3. Prepare interpretation guides for organic soils using as an example the guides prepared in the northcentral and northeastern states.

The committee recommends the adoption of the aforementioned guides, presented at and printed in the proceedings of the 1975 National Soil Survey Conference, as interim guides for field testing.

Charge 4. Evaluate procedure now used for obtaining crop yield potential.

Committee response ranged from none to the expression of satisfaction with the present system in some states. There seems to be little uniformity in the method of collection or expression of reliance on yield data.

Many gatherers of data experience great difficulty in the collection process. Many voice frustration with the method of display of yield data and the lack of timeliness of its display in published soil surveys. Collection of data over the life span of "project-type" soil surveys would in many cases present a "skewed" picture of the normal range of yields of many crops. Less frustration has been expressed concerning collection or display of yield data on native (range) vegetation and forest products than on crop yields.

NATIONAL COOPERATIVE SOIL SURVEY
WESTERN REGIONAL WORK PLANNING CONFERENCE
PHOENIX, ARIZONA, FEBRUARY 9-13, 1976

COMMITTEE NO. 8 REPORT

SOIL SURVEYS FOR WOODLAND, RANGE, AND WILDLIFE

Committee Members:

F. Peterson (UNR, Nevada), Chmn.
G. Otte (SCS, Portland)
'I. Fosberg (UI, Idaho).
C. Meurisse (FS, Ore)
G. Kennedy (SCS, Calif.)
R. Seay (SCS, N. Mex.)
T. Collins (FS, Alaska)
V. Hugie (SCS, Portland)
R. Parsons (SCS, Portland)
D. Richmond (SCS, Ariz.)
J. Allen (SCS, Ore.)
H Havens (SCS, Ariz.)
A. Southard (USU, Utah)
J. Stroehlein (UA, Ariz.)
H. Waugh (BIA, El. Mex.)

Charges to Committee No. 8

(1) "Study relationship between interpretive groupings such as range sites and ecological sites, woodland sites and ecological sites and mapping units.

(2) 'Identify the ..[requirements for] designing a mapping unit to be interpreted for range sites, woodland sites, ecological sites, etc. Develop a model that can be used for all."

(3) "Identify means of making useful interpretations of multitaxa soil mapping units.'

(41 'Prepare ways of using ADP techniques to analyze soil surveys for use in resource planning."

Questions Discussed hy the Committee

The committee was asked to reply to the following questions based on the charges to the committee. The term "habitat type' was used as a preferred tern for "potential vegetation" or other vegetation identification.

Questions Relating to Charge No. 1:

(1) In your experience, do soil consociations identified at some proper taxonomic level always correctly predict the geographic location and kind of habitat type? That is, can we ray that if a soil delineation is not wholly included within, or coincident with a habitat type delineation there is either an error in interpretation, an inclusion of contrasting soil, or that some environmental factor other than soil hasn't been recognized by phasing?

(2) Do soil associations and complexes give vegetative delineations which are useful?
 (a) Is there some limiting small map scale, i.e., minimum size delineation and maximum size contrasting inclusion?
 (b) Is there some limitiny level of taxonomic generalization (including phasing) for the soil components?

(3) Can soil Series consistently predict habitat types? Do they usually have to be phased, or is phasing necessary only for utilitarian purposes such as site index?

(4) Can soil Families, or phases of Families consistently predict habitat types?

(5) Can soil Families, or phases of Families be used for utilitarian interpretations, e.g., herbage yield, forest site index? Do you have examples?

(6) Can soil Subgroups, or phases of them be used to predict habitat types and utilitarian interpretations? Do you have examples?

(7) Could soil Subgroups, Great Groups, Suborders, or Orders be used to predict vegetative potential by classes in categories more generalized than the habitat type?

(8) Do you have examples of vegetation classification hierarchies which might be used as alternatives to the habitat type-level for interpreting 3rd, 4th, or 5th Order soil surveys?

(9) Would it be useful to test higher-level vegetation classes for interpreting 3rd, and 4th Order soil surveys? Who should do this testing, how?

Questions Relating to Change No. 2:

(10) When you make vegetation interpretations do you work from soil properties (e.g., soil depth, water holding capacity, base saturation, etc.) through site requirements of plants to habitat type, yield, etc?

(11) Or, when you make vegetation interpretations do you use geographic coincidence of certain habitat types with polypedons or larger soil areas identified by (phases of) soil Series or higher taxa?

(12) Is it reasonable that some one kind of map unit design (e.g., consociations of phases of soil Series) should be, or could be advocated as a panacea for vegetation interpretations?

Questions Relating to Change No. 3:

(13) In your experience, can soil complexes or associations be interpreted usefully for vegetation potential?
   (a) Can the soil component identification be above the level of phases of soil Series?
   (b) Are landform units (i.e., those defined primarily by other than proportions and pattern of constituent soils) interpretable?

(14) Should interpretive vegetation maps made from, and having some or all delineation boundaries coinciding with soil complex or association delineation boundaries show only one dominant vegetation unit per delineation, or should they indicate proportions of component vegetation units?

Questions Relating to Change No. 4:

(15) Would ADP input effort be profitable in the current situation where vegetation units are identified by *ad hoc*, uncorrelated names of only local and temporal significance?

(16) Is there a large enough, general enough body of knowledge on relations of soil properties to hahitat types, single species occurrence, yield, etc., to justify efforts at ADP analysis for soil property to vegetation interpretation results?

Committee Replies and Discussion

A number of committee members made extensive replies to the above leading questions posed by the chairman. They agreed on some points, diverged on others, and considered a few questions to be inconsequential. In summary, the committee correspondence suggested that there is a need for more effective interpretive techniques for Order 3, 4, and 5 soil surveys (or analogous generalized soil maps, or interpretively generated vegetation maps). More elaborate--perhaps more consistent--definition and description of multitaxa mapping units seems a precondition to better interpretations. Renewed informal and formal research on vegetation-soil relations is another apparent precondition. Some members considered rationalization of vegetation nomenclature, hierarchical classification, and mapping concepts a desirable goal to be encouraged. Several members stressed that utilitarian interpretations (e.g., productivity, management technique, reseeding, etc.) are much more important to users than maps of potential vegetation. The problems of comparability of various resource inventory of interpretive maps was introduced, but not pursued.

Recommendations from the Conference

A working draft report, summaries of committee correspondence replies to leading questions, and a set of tentative recommendations were presented to the entire conference. They encouraged vigorous discussion on several points. The conference members showed particular interest in soil moisture regime - natural vegetation relations. The conference approved the following recommendations from Committee 8:

(1) Vegetation units, or landscape areas with an ecological potential to support a particular vegetation (e.g., hahitat type) should be named after their identifying plant communities, in addition to common names, and should be at least regionally correlated before they are used for soil-vegetation interpretations.

(2) The basis for making soil-vegetation interpretations (e.g., habitat types for various soils) should he identified in soil survey reports, as should the basis for any other soil interpretation. (Soil properties and geographic correlation are two broad categories for soil-vegetation interpretation criteria.)

(3) Vegetation specialists should be encouraged to provide one or several heirarchical vegetation-landscape classifications for use with order 3, 4, and 5 soil surveys.

(4) The SCS Soil Survey Investigations unit should he encouraged to give priority to field studies of soil moisture and temperature regimes and related vegetation pattern% and management responses.

(5) Regional efforts at routine ADP analysis of soils-vegetation interpretations are not warranted at the present time. Analyses of selected data for research purposes should be encouraged.

(6) Vegetation specialists should be encouraged to describe the techniques and concepts hy which they map vegetation and define mapping units, so that definitive analyses of soil map-vegetation map comparability can be made.

NATIONAL COOPERATIVE SOIL SURVEY

Western Regional Conference Proceedings

San Diego, California
January 21-25, 1974

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

San Diego, California
January 21-25, 1974

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SAN DIEGO, CALIFORNIA
JANUARY 21-25, 1974

MONDAY, JANUARY 21 Chairman: R. Huff

9:00 - 12:00	Registration - Bahia Hotel, Mission Bay, San Diego, California Conference in Del Mar Room, Bahia Hotel
1:00 - 1:15	Announcements and Introductions
1:15 - 1:30	Welcome to California - G. Stone
1:30 - 1:45	Welcome from California Agricultural Experiment Station
1:45 - 2:30	Developments in Soil Survey in the Western Region - J. M. Williams
2:30 - 2:45	Recess
2:45 - 3:15	What's New in Cartographic? - R. Wilson
3:15 - 4:30	Report by Committee 1 - Improve Soil Survey Techniques - G. Simonson

TUESDAY, JANUARY 22 Chairman: J. Williams

8:00 - 9:30	Report by Committee 2 - Modernizing Soil Survey Publications - F. F. Peterson
9:30 -10:00	Development of K factor for California Soils - G. Huntington
10:00 - 10:15	Recess
10:15 - 11:45	Report of Committee 3 - Waste Disposal on Land - J. Allen
	Chairman: E. Richlen
1:15 - 2:45	Report of Committee 4 - Techniques for Measuring Source and Yield of Sediment - J. Corliss
2:45 - 3:00	Recess
3:00 - 4:30	Report of Committee 5 - Water Relations in Soils - E. Naphan

WEDNESDAY, JANUARY 23 Chairman: V. Chenoweth

8:00 - 9:30	Report of Committee 6 - Classification of Soils That Have Been Altered By Mining Operations and Interpretations - F. Miller
9:30 -10:00	Soil Survey Investigations in the West - D. Nettleton
10:00 -10:15	Recess
10:15 -11:45	Report of Committee 7 - Soil Taxonomy - T. Holder
	Chairman: J. Hagihara
1:15 - 4:30	Use of Soil Surveys and Interpretations in County and Regional Land Use Planning- Roy Griffin, Senior Planner, San Diego County
4:30 - 5:00	Plans for field trip on Thursday, January 24 - R. Huff

THURSDAY, JANUARY 24 Chairman: Roy Griffin assisted by L. Bates, G. Kennedy, J. Smith and I. Seslander

8:00 - 5:00	Leave Bahia Hotel by bus - Examine soils, land use and land use planning. Effects of climate on soil morphology, classification and vegetation.

FRIDAY, JANUARY 25 Chairman: A. Levin

8:00 - 9:30	Report of Committee 8 - Improving Soil Survey Interpretations - R. Mitchel
9:30-10:15	National Soil Survey Program - William Johnson
10:15-10:30	Recess
10:30-12:00	Report of Committee 9 - Classification of Organic Soils and Their Interpretations- S. Rieger
1:15 - 2:45	Report of Committee 10 - Description of Internal Properties of Soils - T. Hutchings
2:45 - 3:00	Recess
3:00 - 3:30	Business Meeting
3:30 - 4:00	Conference Summary - Gordon Huntington

COMMITTEE MEMBERSHIP ASSIGNMENT
WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA
JANUARY 21-25, 1974

Committee 1 - Improve Soil Survey Techniques

G. H. Simonson, Chairman
D. L. Bannister
J. F. Corliss
T. B. Hutchings
C. A. Nielson
A. G. Sherrell
H. R. Sketchley
R. E. Wilson

Committee 2 - Modernizing Soil Survey Publications

F. F. Peterson, Chairman
V. O. Chenoweth
R. D. Heil
R. W. Kover
L. N. Langan
H. K. Omodt
J. W. Rogers
M. Smalley
W. A. Starr
W. A. Wertz

Committee 3 - Waste Disposal on Land

J. H. Allen, Chairman
M. A. Fosberg
C. W. Guernsey
D. H. Hendricks
L. L. Joos
L. N. Langan
W. D. Nettleton
T. W. Priest
E. M. Richlen
P. C. Singleton
H. R. Sketchley

Committee 4 - Techniques For Measuring Source and Yield of Sediment

J. F. Corliss, Chairman
F. A. Bahr
O. F. Bailey
D. A. Bannister
L. D. Giese
J. Hagihara
G. L. Huntington
C. A. Lowitz
E. A. Naphan
C. A. Nielson
A. G. Sherrell

Committee 5 - Water Relations in Soils

E. A. Naphan, Chairman
J. E. Brown
R. D. Heil
T. J. Holder
H. Ikawa
C. A. Lowitz
F. T. Miller
R. F. Mitchel
W. D. Nettleton
E. M. Richlen
W. A. Starr

Committee 6 - Classification of Soils That Have Been Altered By Mining Operations and Interpretations

J. W. Rogers, Chairman
V. K. Hugie
R. F. Kronenberger
P. C. Singleton

Committee 7 - Soil Taxonomy

T. J. Holder, Chairman
L. D. Giese
D. H. Hendricks
G. L. Huntington
G. H. Kennedy
F. T. Miller
R. F. Mitchel
S. Rieger
A. R. Southard
W. A. Wertz

Committee 8 - Improving Soil Survey Interpretations

R. F. Mitchel, Chairman
J. H. Allen
V. O. Chenoweth
T. Collins
M. A. Fosberg
J. Hagihara
T. B. Hutchings
R. W. Kover
L. N. Langan
T. W. Priest

Committee 9 - Classification of Organic Soils and Their Interpretations

S. Rieger, Chairman
T. Collins
G. H. Kennedy
W. D. Nettleton
J. J. Rasmussen

Committee 10 - Description of Internal Properties of Soils

T. B. Hutchings, Chairman
A. F. Bahr
O. F. Bailey
D. F. Bauer
J. E. Brown
C. W. Guernsey
H. Ikawa
A. O. Ness
F. F. Peterson
G. H. Simonson
M. W. Smalley
A. R. Southard

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Minutes of Annual Business Meeting, January 22, 1974
Del Mar Room, Bahia Hotel, San Diego, California

The meeting was opened by Conference Chairman Dick Huff, State Soil Scientist, California.

A discussion was held on the dates and location of the 1976 conference.

Carl Guernsey, State Soil Scientist, Arizona, invited the group to meet in Phoenix in 1976. Some discussion was held on a permanent meeting place vs the rotating program now being followed. Under the permanent location plan, the chairmanship would rotate. San Diego was offered as the permanent meeting site by Dick Huff.

It was moved by Dr. Gerald Simonson, Oregon State University, and seconded by Bob Mitchel, State Soil Scientist, Washington, that we accept the offer to meet in Phoenix, Arizona in 1976, and decide the issue of a permanent meeting location at that time. Motion passed.

It was moved by Ed Naphan, State Soil Scientist, Nevada, and seconded by L. M. Hicklen, USFS, Missoula, Montana, that the meeting dates be changed to the second full week in February. Motion passed.

Jim Nagihara, BLM, Denver, Colorado, asked about procedures for inviting guests to the conference. Mel Williams stated guests could be invited-but they would not be voting members of the conference. We need to hold the number to a minimum based on availability of facilities etc. The local chairman should be kept informed of invited guests, and determine if they can be accommodated.

Mel Williams informed the conference that with their approval he would revise the by-laws to reflect the changes in the States included as members of the conference. It was agreed Mel should proceed with these needed changes.

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

San Diego, California - January 21-25, 1974

WELCOME TO CALIFORNIA

I am happy to welcome you to San Diego for your Work Planning Conference this year. It is a special pleasure to welcome you considering the energy crisis we face, the budget and travel restrictions confronting us, and the diversified demands on all of our time.

It is for these same reasons that I urge each of your committees to come up with positive and constructive solutions to the many problems you will be addressing yourselves to this week.

It is appropriate that you are meeting in San Diego this year. San Diego is a County that is making maximum use of its available resource data in the planning program.

The published soil survey of San Diego which you will receive at this meeting is a prime example of what Resource Conservation Districts, the County and Regional Planning Departments, and a number of State and Federal agencies can do when they work together.

In this case the San Diego Association of Resource Conservation Districts determined there was a need to accelerate the soil survey of the county. The Directors were also aware that the basic resource data contained in a soil survey would be an invaluable tool for use by the San Diego County, and Regional Planning agencies. Through the efforts of the association of Districts a prospectus outlining the soil survey was developed and an agreement signed between the County Board of Supervisors and the Service.

To help finance the survey, the County received a HUD-701 Grant. However, I am sure Mr. Griffin will tell you more about this when he talks to you later in your program.

I do want to highlight a few unique and innovative points in this project. As you will note the survey is in 2 volumes: Volume I-Soil Facts and Volume II-Soil Interpretations. This will make it easier to update or reevaluate the interpretations as new data or information become available.

Among the other more important innovations in this survey is the fact that Volume II was written-in part-by 2 community planners. This made it possible to write in a different style, and include discussions not normally included in soil surveys published under the National Cooperative Soil Survey Program.

Yet another first in this survey is the inclusion of interpretations developed specifically for use in San Diego County. Local planners assisted soil scientists in developing suitable criteria. Some of these special interpretations include information pertinent to homesites, construction materials, and conversion of brushland to grass. This latter interpretation is especially important in an area such as San Diego where brush fires can be extremely disastrous and costly.

San Diego planners asked that the soil map be published at a scale of 1:24,000-or the same as USGS 7.5 minute quads. At first we rejected this as not being practical, but finally agreed to this request. We found in compiling the 2 million plus acres of San Diego County on 1:24,000 photos, that we did not lose a single delineation. Based on this, we decided that all future detailed soil surveys published in California will be at a scale of 1:24,000, and are confident we will not sacrifice anything in the way of detail.

Probably the biggest problem-or drawback-of the published maps in this survey is they are printed on a semi-controlled aerial mosaic. We would much prefer to have used orthophoto quads had they been available. We will use orthophotos wherever possible in our future soil publi-

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Remarks by G. H. Stone, State Conservationist, Soil Conservation Service, Davis, California, at the Western Regional Work Planning Conference of the National Cooperative Soil Survey, San Diego, California
January 21-25, 1974

cations. To date they have been used in about six survey areas-for field work in some, and for publication maps in others. The orthophoto quads are giving us a superior base map for publications and are being received very enthusiastically by planners, engineers, and other users of soil surveys.

Another program we have instituted in California is the issuance of interim soil survey reports. Within about 3-6 months after the completion of the map compilation and RTSC technical review of the manuscript we have an interim report in the hands of users. The narrative report is basically the same document we submit to Washington with blue-line maps made from mylar film-positives of the field compiled maps.

To overcome personnel ceilings and budget limitations, we are embarking on a program of using Intergovernmental Personnel Act (IPA) agreements to improve and advance our soil survey program. Our first agreement went into effect January 7. Under this agreement the Service is providing the West Los Angeles RCD with a GS-11 survey leader for a soil survey of the San Fernando Valley. To complete the survey, the RCD is hiring 2 additional soil scientists, whose qualifications must meet civil service requirements. Plans call for completing the some 90,000 acres, including a report, in 2 years.

Negotiations are also under way with Santa Cruz County to add an extra soil scientist to the survey party. This man will provide the county with needed expertise at a stage in the planning process, where it is needed. He will also help them develop a computer program for county planning using the soil survey and a special USGS slide hazard and earthquake hazard survey. Initial discussions are also underway in other survey areas for IPA agreements.

Another program we are trying to initiate is the use of color and/or color infra red photography to aid in speeding up soil survey field work, while improving the quality of the soil survey. It has proven partially successful in 2 trial survey areas. We hope to become operational next fiscal year. We need first to develop a training program on interpreting the various remote-sensing techniques and need to secure the required remote-sensing materials.

I am sure that each of you could discuss ways you have moved foreward in soil survey activities in your respective states. However, the very fact you are here in San Diego to discuss such topics as Improve Soil Survey Techniques; Modernizing Soil Survey Publications; Waste Disposal on Land; Techniques for Measuring Source and Yield of Sediments, and the other six subjects covered by your 10 committees, shows we still have a long way to go. So in your deliberations this week, I urge you to be creative and forward thinking, in your search for meeting the needs of people outside the National Cooperative Soil Survey.

I plan on being with you through tomorrow, and my staff and I will do everything possible to make your stay in San Diego an enjoyable one.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

The Challenge of the Soil Survey

William M. Johnson
Deputy Administrator for Soil Survey, Soil Conservation Service

When the Soil Survey began in 1899, it was charged with the responsibility for classification and mapping of soils in agricultural districts in order to show the distribution of the various soil types with a view to determining the adaptability to certain crops and for management treatment. The Soil Survey was an instant success in the sense that demands for its acceleration and expansion were apparent almost immediately. The benefits of a soil survey were apparent to the Congress and a separate Bureau of Soils was created in 1901. Milton Whitney asked for an appropriation of $80,000 in 1901, which may not seem very big, but it must be remembered that as Chief of the Soil Survey, Whitney's salary was $2,000 a year and the survey costs were running about $3.25 a square mile, including publication, which comes to 5 cents an acre. Considering the slowness and difficulty of transport and the labor-intensive methods used in field, laboratory, and cartographic shops, these costs seem extraordinarily low. Today soil surveys cost about 77 cents an acre and an average county represents an investment of federal and state funds of about $375,000. During the first year, 1899, our soil scientists surveyed 720,000 acres. The rate of mapping has increased over the years, but it has never caught up to the demand. We have adapted the machines of modern technology, even including satellites; we have increased the scale and detail of mapping; and we have shifted our attention in part from the farm to the city. We have come to see the soil as a key element of the environment with a substantial role in most facets of basic human activities. We have improved our efficiency greatly, and have expanded the number and varieties of interpretations of the soil survey. But this is not good enough. We still have a large backlog of unpublished soil surveys. Our technology is still too traditional, too slow, and too narrow. There are still too many people who do not know that the soil survey exists and too many who fail to see the need to base their land use decisions on facts about the soil. How can we overcome these difficulties? What is our objective and what is our timetable?

Soil Survey Objectives

The objective of the soil survey program has two facets: to complete soil surveys, including publication, of all land in the United States and the Caribbean Area, and to provide this soil information to the people who make land use decisions. This double-barreled objective can be expressed as four long-range goals.

Mapping and Publication

Our first goal, of course, is to complete field mapping and publication as soon as possible. At the present rate this means about another 25 years. I need not tell you that this is too slow. Means must be found to accelerate field mapping at the same time that quality is maintained or enhanced. This may be accomplished by better soil survey work plans, better designed legends, closer fit between soil survey design and the needs of the area, and by more efficient field operations, including the use of better photographic imagery and improved field transport. Of course, we need not only detailed and reconnaissance survey maps, but general maps of various scales. We do not call these general maps soil surveys because they are compiled from other data. General maps, though, are useful for land use planning in counties, multi-county areas, and resource conservation and development projects as well as for general planning in states, river basins, and multi-state regions. To meet some of these demands, we are compiling a new soil map of the United States at a scale of 1:1,000,000. We expect to complete and publish this map by 1983.

Soil surveys on some of our island holdings, like Guam and American Samoa, are needed for national planning and development. We have authority for making soil surveys of these islands, but so far limited resources and low priorities have prevented anything but preliminary studies. When the [redacted] then all we need to do is reinterpret the survey as technology changes.

Along with acceleration of field mapping and the maintenance of up-to-date interpretations, it is essential that we maintain or improve the quality of both mapping and interpretations. Our surveys must meet the tests of both scientific and legal inquiry. They must be accurate, consistent, and reliable within defined limits. I do not have to tell you that this does not mean we must delineate every soil condition we can recognize. It does mean that our surveys must be trustworthy within the quality standards we ourselves specify. This means that field mapping must be accurate, and the base on which the survey is published must be accurate and precise within specified limits. The classification must stand up under rigorous testing, and this means that we must have field and laboratory data to support the classification and interpretations.

Making Soil Information Readily Available

Our second major goal is to make soil surveys and interpretations available to large numbers of people for decision making on a wide variety of uses. Farmers, ranchers, and foresters still need our soil surveys. Highway planners and those who construct pipelines and airfields must take account of soil conditions. Recreation developments and town-and-country planning of residential, industrial, and commercial developments are enormously affected by soil conditions. Increasingly, soil surveys are used for locating areas of potential flood hazards. As our concern increases for both conservation of resources and the quality of the environment, so does the demand for soil surveys increase. As a national land use planning and assistance law comes into action, requests for soil surveys everywhere will multiply and become more urgent. We may expect a louder and louder clamor for soil surveys as states, counties, and cities take a more active role in the planning and regulation of land use.

The publication of soil surveys in standard format is the only way of assuring that our work is available to everyone who needs it, whether he lives in the survey area or 2,000 miles away. We sometimes forget that the use of the soil survey by people outside the county is often more important, more critical to the state or nation, than the use of the survey within the county. It is one objective of the Soil Survey to publish the surveys as soon as possible after maps and text are ready. Our track record has not been outstanding, but we are making some improvements. By your efforts in states and [redacted] ways must be found to increase the rate of publication by at least 50 percent, if not 100 percent, over the present rate. We want to be able to get our soil survey information, both maps and interpretations, to users while the survey is still in progress, by means of special interim publications. We want to have the standard report in the hands of users within a year of completion of field work. Neither of these goals is impossible, but they call for concerted effort, adherence to time schedules, improvement in techniques, and some extra money.

A Soil Information System

As a part of our communications among ourselves as well as with users, we have visualized a Soil Information System to improve the processing and availability of soil survey data. It is our intention to automate the storage and handling of soil survey data of all kinds, both point data and spatial data. We have made some progress toward this system. You know about the Pedon Data File, and about the ADP procedures used in the laboratories to compute final data values and tabulate them. You know about the Soil Classification File and you have seen the printouts of the index and classification tables. We are currently making good progress in storing interpretations from the Soils-5 form in the computer at Iowa State. It is a pleasure to tell you we are in the process of acquiring the components we need for the Advanced Mapping System, which will largely automate the storage of soil map information and make possible the automatic production of a variety of interpretive maps. Also we are able to expand the Fort Worth trials on computer-generated text and interpretive tables for interim and final text manuscripts, as well as the cellular interpretive maps based on the MIADS procedure. I believe that Mel Williams and his staff are working with you now to start using some of this technology in the western states.

Onsite Assistance

Our third major goal is to provide people with detailed soil interpretations for use in planning specific areas that are being developed. Soil scientists, conservationists, engineers, extension agents, and even university professors are called upon to make an increasing number of onsite technical soil investigations so that sound land use decisions will be made for specific sites or tracts of land. The number of these requests is increasing every year as states and counties pass more laws, regulations, and codes regulating sediment production, pollution, and just general land use. The need for onsite counseling increases. Even after a detailed soil survey has been completed and published, there is still need for onsite assistance when it comes to designing expensive structures or other developments. There is great opportunity here for private consultants, but too few of them are practicing in most states, so SCS and the universities get most of the requests for assistance.

Communications With Users

Finally, our fourth long range goal is to help SCS staff, university staff, Forest Service, BLM, BIA, and other government staffs, as well as legislators and planners in many public agencies, to understand the potentials of soil resources and the importance of knowing their limitations for various uses. This is our communications problem. We know how soils are distributed, classified, and how they behave. We know the implications of the soil behavior to the siting and design of highways, parks, hospitals, shopping centers, and suburban housing, but we do not make the land use decisions. Those decisions are made by planning agencies, by state and county officials, by the boards of directors of large corporations, and by individual landowners numbering in the millions. We have a critical task of making known our expertise and the value of our product. Now obviously, soil potentials and limitations alone do not and should not determine soil use and soil treatment. But in making land use plans and regulations and designing new structures, decision makers need to consider the soil first so that they understand the implications of various alternatives--what determines the success of a project, the acceptance of regulations, benefit-cost ratios, and impacts on the resources and the environment.

We have come a long way since 1899 and we have every right to be proud of the status of soil survey today. We do not have a right to be complacent and to sit back and coast. Innovation, imagination, [redacted]

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE

OF THE COOPERATIVE SOIL SURVEY

San Diego, California January 21-25, 1974

DEVELOPMENT OF THE K FACTOR FOR CALIFORNIA SOILS

Gordon L. Huntington

Land and soil erosion is an exceedingly complex phenomenon. All of us assembled here are well aware of this through our own direct or indirect experiences and studies. It has been a phenomenon of concern to man for milennia. Over the centuries, he has learned many empirical methods of control and applied them with varying degrees of success. However, he has also ignored many object lessons from nature with consequent deterioration or disappearance of his earlier societies.

Most of our present knowledge and understanding of erosion has been gained within the past 50 years because of an aroused national concern - a concern, incidentally, which also lead to the establishment of the Soil Conservation Service. Although the concern was nationwide, most efforts to understand erosion and to develop effective protective practices were concentrated on the lands east of the Rockies where erosion of farmlands, by both wind and water, had become an extensive and severe problem. This is not to say that the problem was ignored in the western states. By no means! But the west, with its much greater variety of climate and terrain, was much more varied in the nature, degree, and extent of its erosion problems. Consequently, such studies as were undertaken, were scattered and difficult to relate. No general principles could be derived from these data alone. Some of the earliest systematic work on soil erosion, however, was begun on western rangeland by the Forest Service, but the bulk of our present knowledge has grown from the combined efforts of Agricultural Research Service, Soil Conservation Service, Forest Service, and State Agricultural Experiment Station people working on erosion experiment stations in the midwest and east.

In California, cropland erosion has, for the most part, not been a severe problem, consequently little formal research has been conducted on these lands. Certainly, existing soil erosion has been mapped in standard soil surveys and in farm surveys; erosion hazards have been estimated, and practices have been recommended to minimize possible soil losses. Information for these estimates and recommendations came both from local experience and from data importation from other parts of the country where intensive studies had been made. The fortunate low level of erosion problems reflects to a large degree the climate and location of most farmlands in this state. Most of these lands are in broad, nearly level valleys in a Mediterranean or Desertic environment in which rainfall occurs only during winter months when little cultivation takes place. In addition, precipitation intensities on these lands are normally not high, so that rainfall erosivity is relatively low.

Wind erosion of some California farmlands has probably received more widespread attention in the recent past. Areas of significant wind erosion have existed on the Sacramento-San Joaquin River-Delta lands, on the west side of the central and southern San Joaquin Valley, and in the northern Coachella Valley. There are other areas of lesser extent. Concerns over this kind of erosion arose primarily among those who received the products of the erosion - namely, residents of downwind towns and cities. Reasonable control of the areas subject to wind erosion has been achieved recently by changes in farming practices, extension of Central Valley irrigation water, and establishment of protective windbreaks.

This interest in wind erosion, and in finding effective control measures, carried with it portents of the present increasing concern over water erosion on our non-agricultural lands. It also harked back in time to the first erosion control legislation in the state - the debris law - that closed hydraulic mining for gold in the Sierra to curb "slicken" deposits on farmlands in the Sacramento Valley below.

Although rainfall erosion is not an overly serious problem to much of California's farmland there is a potential for very serious erosional problems on the non-agricultural lands that comprise about 90 percent of the state. Over the years, concern for erosion and sediment yield on determining or attempting to predict sediment yield for watershed or subwatershed units, often encompassing many kinds of soils.

In very recent years there has been an acceleration of development and use intensification of these non-agricultural lands. This can be seen in the logging activities on both private and public land, continued extensive grazing of range land, and an increasing dependence upon watershed yields to supply growing domestic, industrial, and agricultural water needs, as well as hydro-energy and ecologic requirements. Superimposed on this has been an explosive increase in recreational use and development of our wild lands, including second homesite subdivision, recreational center development, and off-road vehicular uses - the latter particularly in the desert areas.

Soil erosion can be much greater on our wild lands than on our farmlands because of much steeper slopes and, in part, greater quantities of rainfall. Intensification of use is altering or removing the natural protective cover and opening the door to serious soil loss and downstream damage. To counter this, better planning and management is needed to a far greater degree now than in the past. Environmental protection laws underscore this, and in some cases, environmental groups are pressing for absolute protection of lakes and streams from particulate pollution or eutrophication. To accomplish a reasonable balance, much more knowledge is needed of the erosivity of our rains, and the erodibility of our soils.

Our work at the University in this area is new. We are "Johnny-come-lately" in the field of soil erosion to which much excellent [illegible]

Caution could dictate forebearance in the Equation's use until adequate local data has been gathered. Many years might be required for this. Norman Hudson, in his book - Soil Conservation - offers advice to under-developed countries concerning use of the Equation when rainfall records and related soil loss data are sparse or lacking, but where the need is immediate for reasonable management decisions. He encourages use of the basic principles of the Equation. These can be related to meager existing information in order to arrive at "best guesstimates" for guidance. This is preferable to waiting a number of years for better data and postponing urgent decisions in the meantime.

In California, we can consider ourselves as an under-developed region in much the same sense because of our lack of sufficiently detailed rainfall records that truly reflect local climatic variability, plus our lack of related records of erosional losses from specific soils under known conditions. The same is true for much of the west.

During the coming year, the Soil Conservation Service will determine K factor values for all western soil series using Wischmeier's nomograph. R factor values, or erosion-index ratings, will be determined from best available rainfall records - thus following Hudson's recommended approach. Tests of the applicability of the soil loss equation to existing western conditions will follow.

In California, the Agricultural Experiment Station will collaborate with SCS and Forest Service personnel in field studies to evaluate the initial approximations of the equation factors, particularly the K factor. The Department of Soils and Plant Nutrition at Davis has two soil erosion research projects presently underway, and a third in preparation. The latter will involve a search for relationships between the erosion of soils as natural bodies and the erosion of similar soil material from the viewpoint of the civil engineer. The following slides will outline the projects underway and the methods used in evaluating nomograph-determined K factors for California soils.

The first project is NSF-RANN sponsored and is part of a larger project in the Tahoe basin studying the physical and biological, as well as socioeconomic and political effects of continued development of the basin. In our project, erosion plots have been established on 7 prominent soils of the basin in an endeavor to determine the erodibility of the soils. This attempts direct determination of storm and average annual K values for the particular soils. The purpose is to provide practical information for planners and land managers, as well as to relate measured properties of the local soils with their observed erosion behavior.

The second study is part of a western regional research project of Land Grant Colleges, sponsored by Hatch funds, titled Soil Interpretations and Socio-Economic Criteria for Land Use Planning (W-125). Our part of this project has been coordinated initially with the first project, but has a broader scope of activity reaching out to other areas of California. It is endeavoring to evaluate the soil loss equation and K factor determinations directly, by use of erosion plots on selected soils, and relatively, by sediment yield produced on site through use of a portable rainfall simulator that was developed for this project. Relative studies thus far indicate only a fair correlation between sediment yield and nomographed K factor values when these are ranked and compared.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

San Diego, California January 21-25, 1974

CONFERENCE SUMMARY
Gordon L. Huntington

Our regional conference for 1974 now draws to a close. It has become customary at this point to conclude with a summary of our deliberations. In reviewing the work of this week to prepare these remarks, it occurred to me that a routine review would add little to the accomplishments of the conference. As a matter of fact, each of us at this moment has his own summary in the form of his notes, recollections, and participation in the week's events, as well as copies of the regional committee reports that will be passed on to the national committees.

However, it would be well for us to reflect on what kind of a conference this has been. To be sure it has been a very good one, but more than this we should recognize it as a particular juncture of current effort and accomplishment on a time line that reaches back to the days of Soils and Men and before, as well as a link to the future. Each conference addresses itself to current concerns in the on-going job of gathering, interpreting, and applying soil and land facts for positive, long-range societal benefit.

The regional concerns of this conference can be seen in the committee charges which reflect both continuing deliberations of long standing, and new or renewed areas of interest. Under continuing committee action, we are endeavoring to improve soil survey techniques and efficiency in soil survey report publication, as well as soil characterization, classification, and interpretation. New or renewed interests find us responding to the challenges of waste disposal on land, interpretive evaluation of strip mine tailings, the classification and interpretive evaluation of organic soils, and the erosion of western lands.

The committee objectives in all areas are to review, revise, clarify, and improve the Soil Survey. Questions or uncertainties remain in some of the charges, but much progress is being made and is of great immediate importance if we are to achieve recently projected annual goals for survey area completion and survey report publication.

The accomplishments of this conference are not all to be found in review of the agenda, the committee reports, or the conference report. We should also take into account the values involved in the interaction between participants in the many personal exchanges of viewpoints and consequent stimulation of new individual thoughts and ideas. These will be carried back by many of us to our states or regions of endeavor for further consideration, local trial, and evaluation. This can be reviewed neither in detail nor in outline at this time, but will assuredly have its effect in local work and future committee actions. As an example, may I briefly present some of my own thoughts and intentions resulting from the conference.

For the past 23 years, the California Soil Survey Work Planning Conference has had a one-day meeting each year involving representation from the various state and federal agencies active in soil survey. At the close of the last meeting, it was agreed that a workshop format covering several days be explored by the Chairman, and if found satisfactory, to be adopted. As Chairman of the conference, I will add local and state planners to the list of participants invited. A proposed format for the workshop will include groups built around local members of the existing regional committees. California input to the regional committee charges will be examined. Input from the planners viewpoint will be encouraged. Thus, two formal opportunities will exist to pool and evaluate ideas prior to each regional conference.

Now, speaking for the California Agricultural Experiment Station, I want to thank you all, conference members and guests, for your contributions to a successful meeting. Special recognition and thanks are due the steering committee for planning and arranging the conference and field trip; the Cooperative Extension Service for its material assistance and participation in the program; and the San Diego County Planning Department, in particular Roy Griffin. I wish you all a safe journey on your respective trips home, and until the group reconvenes again on February 9, 1976, in Phoenix, Arizona, -- in the words of early California -- "¡Que le vaya [illegible]

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

San Diego, California
January 21-25, 1974
Committee I

Report of Committee I - Improve Soil Survey Techniques

The following charges were given the Committee:

Charge 1 - Assess the application of remote sensing techniques for speeding up soil surveys especially in areas of extensive use. Incorporate findings of various states on such items as use of ERTS photography, use of 35mm color slides, infrared, etc. Recommend techniques that are practical and can be adopted as field measures.

Charge 2 - Assess the various techniques for use of ADP in soil survey reports. This should include the experience of the states with the Ames Statistical Lab work and any pilot study such as the Montana Project.

Both of these subjects are receiving quite a bit of attention nationally and much of the current work is not yet published. The committee members were asked by the chairman to comment on the present situation and future prospects for applications in soil survey, based on their knowledge or experience, particularly within their own agency.

Committee comments and information regarding charge 1 - to assess the application of remote sensing techniques for speeding up soil survey, especially in areas of extensive use - are summarized as follows:

Photo interpretation is the remote sensing technique generally used and of greatest importance in soil mapping. The standard field sheet used in soil survey since the 1930's has been the panchromatic black and white aerial photograph. The aerial photo is used as a map base, for orientation, direct observation of soil patterns by tonal difference, and indirect inferences of soil occurence through correlations with observable features such as landforms, drainage patterns, topography, vegetation, and even land use.

Soils are mapped and classified through direct observations of profiles and landscape relationships in the field. Photo interpretation is generally a valuable tool for locating soil differences and soil boundaries, but the degree to which it facilitates soil mapping varies widely with such factors as the nature of the soil landscape, the kind and detail of the survey plant cover, quality of the photography, and skill of the mapper. Photo interpretation cannot substitute for profile observations in soil classification and cannot replace soil identification by profile examination in field mapping. It's proper and full use, however, aids greatly in the mapping process, increases efficiency of the mapper, and results in a more accurate soil map.

Many soil surveyers have tended to emphasize use of the aerial photo as a base map and failed to exploit the full potential of photo interpretation as an aid in mapping. The relation of tonal patterns, physiographic features, vegetative cover, and other image characteristics to soil occur- [illegible] features, and be able to use these techniques where applicable in soil mapping.

A variety of photographic products, such as color-infrared and color transparencies or prints, images from film-filter combinations, as well as multispectral scanner data in single band or false color combinations are becoming more widely available for many areas of the U.S. Much of this imagery is flown primarily for experimental use but some, such as, black and white, color, and color-IR highflight photography is available for many areas.

The committee reported a number of ways that black and white highflight, and aerial photography is being used or evaluated for soil mapping.

1. The U.S. Forest Service has 4" = 1 mile color aerial photo coverage for all Forest in Arizona and California. It is considered extremely useful for soil survey because vivid color contrast generally enables identification of geologic changes and different vegetative species. It is well-suited for use in Order 2 and Order 1 surveys. Highflight, 1" = 1 mile panchromatic coverage is available for most forests and is used in Order 3 surveys.

2. In Arizona, U.S.F.S. Soil Scientists have extensively used high altitude aerial photographs from NASA and USGS, including color, standard black and white (panchromatic) and some false color infrared. The scale used is approximately 1" = 1 mile on a 20 x 20" format. These are ideal for the Order 3 soil survey being conducted. Their use has effectively increased mapping proficiency and accuracy.

3. The SCS in California has evaluated use of supplemental color and color-IR photography in portions of several counties. Methods of utilizing low cost 35mm format color and color-IR slides were developed in the Placer County work (C. B. Goudey, presented before Div. S-5, SSSA, Aug 25, 1970, Tucson, Arizona). The slides were studied in the pre-mapping stages in conjunction with the black and white field sheets. Color slides helped in distinguishing between some series in areas of exposed surface. Color-IR slides provided indirect inferences of soil texture, depth and drainage through shades of red indicating stage and vigor of vegetative growth. The results indicated an increase in accuracy in boundary location and in determining percentage of inclusions and proportions within soil complexes; more efficient use of field mappers time; and 30 to 60% more information than obtained from black and white photos. Planning the flight time for maximum utility of the photos, particularly color-IR, is important. In Modoc County 9 x 9" color transparencies at 1:35,000 scale were obtained for continuing evaluation during the course of the survey. Preliminary study indicated that soil color patterns are easily seen in this semiarid terrain and the photos were expected to be a significant aid in design and description of mapping units and in making soil delineations.

4. Several BLM Units in Montana are utilizing an inexpensive 35mm system to document range condition. The system is versatile and could have application in soil survey work. It was developed by M. P. Meyer and is described in "A 35mm Aerial Photographic System for Forage and Range Resource Analysis", Minnesota Forestry Research Notes 240#, Jan. 15, 1973.

5. The BLM in Oregon is using high altitude, 1" = 1 mile black and white and color photography in making reconnaissance soil surveys of forest lands. The USFS has used highflight black and white photos throughout Region 5 and elsewhere for mantle stability surveys and soil resource inventories. Oregon State University and the SCS have used black and white highflight coverage for reconnaissance and general soil map compilation throughout the State. Other States have also used highflight photography for reconnaissence and general soil map work.

6. The S.C.S. in Utah is cooperating with the McDonnell Douglas Astronautics Company in the Salt Lake Valley and adjacent mountains to evaluate color and panchromatic aerial photography and multispectral scanner data, including color-IR and thermal-IR. Similar coverage from NASA aircraft has also been obtained. Comparative analysis has not been made as yet.

7. Soil Survey Investigations, SCS carried out a brief evaluation of color-IR transparencies at scales of 1:120,000 and 1:60,000 in a coastal county of North Carolina. (SCS Advisory Soils-18). They reported that color-IR is an extremely useful tool in mapping over a range of conditions, primarily to identify changes in vegetation that correlate with soil differences. Local ground truth must be used in conjunction with subtle color and textural changes on the transparencies for good results. They concluded that color-IR can speed many surveys and be a big help at all levels of intensity, if used by competent soil scientists.

ERTS multispectral scanner data is now available for the entire country, generally for most times of the year, except for cloudy periods. These data include 70mm and 9 x 9 inch format, 1:1,000,000 scale transparencies of the red, green and two near infrared bands; false color recon- [illegible] Digital tapes can also be obtained. Most of these products can be ordered from the USDI, EROS Data Center, Sioux Falls, S. D. States with remote sensing centers or ERTS investigators have catalogues and microfilm files that would facilitate selection of imagery needed. These include the University of California, Berkeley and Davis; Oregon State University; University of Nevada; University of Idaho; Arizona State University; University of Washington; Montana State University; South Dakota State University and University of Utah, among others. Most of these have a file of ERTS imagery that can be inspected and they can advise on getting prints, enlargements, etc.

Satisfactory false color transparencies are being made quickly and economically by use of Diazochrome Film by several investigators. NASA Highflight photography of selected areas has been furnished to most of these investigators. These are generally color-IR transparencies at 1:120,000 and 1:300,000 scales, but may include some panchromatic and narrow band film-filter combinations, or multispectral scanner data. In most cases, these could be available to obtain copies in black and white or color-IR.

Oregon, Nevada, Wyoming, and California have assembled state mosaics of ERTS imagery. The SCS Cartographic Division is compiling controlled mosaics of the continental U.S. These are now available for the western U.S. and Alaska in several scales and sheet segments for bands 5 and 7, and for two seasons. A number of people have recognized that these mosaics would make an excellent base for compiling state general soil maps, providing a synoptic view of physiographic, vegetative and land use features in conjunction with the soil distribution. South Dakota has published a state map of this type already. (AES Info. Series No. 5, South Dakota State Univ., Brookings.)

A single ERTS frame will encompass most counties or soil survey areas. Enlargements to 1:250,000 scale in black and white would provide a useful base for many county general soil maps. Party leaders could also benefit by having these available, particularly during the initial stages of a soil survey, for a overview of the broad terrain differences in the survey area.

A number of ERTS investigations involve applications related to soil survey. Due to the small scale and limitations in resolution, most studies of the photo - imagery has been in relation to broad soil patterns and the soil association level of mapping. Some of these are mentioned below:

1. Weston has found that some improvements could be made in the state soil map of South Dakota based on comparison with color composites of ERTS imagery.

2. Drew has found that the major range sites and associated soils in the sand hills of Nebraska were clearly distinguished using color-IR photography and could also be recognized in larger areas using equivalent ERTS imagery.

3. In Oregon, Simonson and others are using ERTS photos and a highflight mosaic to compile general maps at several scales of soils, geology, and vegetation to present resource information in a coordinated manner for land use planning.

4. Huntington is investigating the possibilities of identifying salt-affected soil areas in California with color composites of ERTS imagery. Recognition of characteristic surface patterns of these soils is possible but stress patterns in vegetation have not been consistently recognized due to lack of resolution with ERTS data.

5. Several investigators around the U.S. have attempted computer assisted classification of the digital data for soil mapping. The digital data has much larger scale capabilities since each data cell is approximately one acre. Also, reflectence in each of the 4 bands can be combined for automatic tonal pattern recognition. Discrimination of tonal differences is more sophisticated than possible by photo interpretation. However it must be emphasized that calibration by ground truth on selected areas is always needed and that tone is only one of several feature characteristics used in photo interpretation. Thus it seems that this technique has some severe limitations for differentiating soil areas. Much depends on reliability of tone signatures for consistent identification of bare soils or other features that correlate with soil differences. The Forest Service is studying the application of this technique for the Soil Resource Inventory of the Plumas National Forest in California.

6. Caprio at Montana State is using ERTS data in studies of phenology, the green wave, brown wave, and solar-thermal energy units associated with changing seasons in the western states. This approach may be useful in relation to determining boundaries of temperature regimes of soils.

Additional comments received at the conference from Jim Hagihara were as follows:

a. The BLM in California has contracted with the Raytheon Corp to pre-type soil and vegetation boundaries on 1:200,000 color aerial photos. The delineations, mapping symbols and other related data were digitized on magnetic tape for storage and retrieval. Nearly 1,000,000 acres have been completed. Satellite imagery (ERTS and Skylab 1), U-2, low level 1:200,000, and 35 mm or 75 mm flown at 1,500 AMT were utilized in photo interpretations. Computer produced overlays were made to be used with 15' GS Quadangles.

b. The BLM has contracted with University of California, Berkeley (UCB) to inventory vegetation, soils and other related resource data on the public lands in the Susanville, California District. They will utilize satellite, U-2 and low level imagery. The latest techniques in automated data processing and map compilation will be utilized.

The following brief list represents some of the principle sources of information about remote sensing applications and techniques. It is by no means comprehensive.

Remote Sensing with special reference to Agriculture and Forestry, 442 pp. National Academy of Sciences. Washington, D. C. 1970

Manual of Photographic Interpretation. Am Soc. of Photogrammetry. 1960. George Banta Co. Inc, Menasha, Wis.

Proceedings of Symposium on Significant Results obtained from the Earth Resources Technology Satellite-1. New Carrollton, Maryland. March 5-9, 1973, in 3 vol. NASA sp-327. U. S. GPO, Washington, D. C. 20402.

Proceedings Third ERTS Symposium, NASA, Goddard Space Flight Center. Greenbelt, MD. Dec. 10-14, 1973 (in press).

Photogrammetric Engineering (Journal articles).

Soil Science of America proceedings (recent Journal articles, Div V).

<u>Recommendations</u>

1. Air photo field sheets should be of high quality. A continued effort should be made to assure use of the best available flight. Often, reference to more than one flight is useful. High altitude and ERTS coverage can be useful in initial stages of detailed surveys, and should be utilized in compilation of general soil maps. Previous conference committees have made similiar recommendations, including providing ortho-photos to the field man when available.

2. Soil mappers should be made aware of special photography such as color and color-IR photographic coverage for their survey area and, where feasible, make use of these products as supplemental aids in pre-mapping and photo interpretation.

<u>Charge 2</u> was to assess various techniques for use of ADP in soil survey reports. Committee response to this charge was quite limited. Future applications of ADP are expected to be extensive. Most of the recent activity has been in system development for storage and retrieval of soil pedon data and interpretive data for soil mapping units. The SCS classification and laboratory data systems are in operation. The preceeding report at this conference described the status of the SCS automated mapping system. Ultimately, the integration of these separate systems are sure to have great impact on the soil survey; particularly in the way we compile reports, handle and compare data, and extract and present information.

The Forest Service is using ADP mainly for storage and retrieval. A few computational programs exist to aid in making interpretations, i.e. water-holding capacity and soil moisture regimes. Most of the storage and retrieval is for mapped information. Two basic systems are used. They are: (1) storage of mapped data by cells (30 cells per square inch) and (2) storage of maps on microfilm for electronic scanning and acre computation (this system has not been extensively used). The Washington Office is working on a system for the storage and retrieval of descriptive and interpretive soil data.

Montana has tested the applications of ADP to a soil survey in progress (McCone County). They have worked with the following applications:

a. Mark sense forms were developed (G. Decker, Agron: Abs. 1973) in Montana to encode pedon descriptions (some examples are available at this conference). Soil scientists encoded the descriptions in the field. Forms were processed at Montana State University and computer written descriptions were returned to the field. In this system a document reader (IBM 1230) is used to punch cards for computer input. Corrections or additions are made on the cards.

b. Copies of typifying pedons were computer written for the descriptive legend and survey handbook. Cost of three copies was less than $.02 per pedon.

c. Current lists of the series and their classification were prepared by computer for the survey area.

d. Programs were written to create the "Summary Table of Soil Characteristics and Qualities". A first approximation of manuscript interpretive tables will be derived by comparing this table with interpretive criteria tables.

Montana has also developed statewide computer data files of soil classification, laboratory characterization data and descriptions, and other pedon descriptions. They have used these files to analize statistical relationships between field soil properties and available waterholding capacity, and to develop guidelines for estimating plant available water.

Oregon is developing a similar system for pedon data using the optical scanning technique for data encoding. They plan to develop programs initially for analizing septic tank performance in relation to soil characteristics and soil phases. Both Montana and Oregon are using data systems compatible with the national SCS System.

Use of data files and computer soil map storage with NIADS has been widely tested by the SCS, S. E. Region to produce interpretive maps. (J. D. Nichols, Agron. ABS., 1973).

Canada has also developed an ADP System for soil survey (M. K. John, <u>et al</u>, "A System of Soils Information Retrieval" Can. J. Soil Sci. 52:351-357, 1972). They are trying to develop a soil series numbering system using numeric codes for various characteristics in combined form.

No information was obtained from the committee members regarding use of Conservation Needs Inventory (CNI) data. A number of uses of these data through ADP processing have been developed in the east and midwest (SCS Advisory CN-1, June, 1973). For instance, Alabama has derived acreages of soils, land use, etc. for use with a state soil association map. South Dakota is studying use of the acreages of the soils and capability units by county for land evaluation. Illinois has made extensive use of the expanded CNI data for numerous reports of soil relationships on a statewide basis. It appears that addition of the soils, slope and erosion data, together with the potential input from soil interpretation subsystems has greatly enhanced the potential of CNI data applications.

Recommendations

The committee recommends that a ADP information "Clearing house" be set up so that statements or abstracts of ADP developments and applications by the various states and agencies can be made available to others. The information should state what computer the program was written for, and who to contact. Possibly the Washington Data Storage and Retrieval Unit under Dwight Swanson could handle this.

Discussion

Committee I report was accepted by the conference following a brief discussion. Slides illustrating ERTS data, high altitude color and color-IR, and 35 mm airphoto applications were shown by Simonson, Wildman and Huntington.

Committee Members

Jerry Simonson - Chairman
Jerry Nielson
Andy Liven
John Corliss
Theron Hutchings
D. L. Bannister
Robert Wilson
Leland Bates

Appendix

A report of the Montana ADP Project for Soil Survey was circulated at the conference and will be appended if it is feasible to reproduce the example forms.

COMMITTEE 1 - Continued

MONTANA ADP PROJECT

FOK

SOIL SURVEY

1. Montana ADP progress report.
2. Instructions for encoding soil morphological data.
3. Codes for mark sense forms.
4. Example mark sense forms for encoding soil morphological data.
5. A computer printed soil morphological description.
6. Example mark sense forms for encoding mapping unit data.
7. A computer printed mapping unit description.
8. A computer printed "Summary Table" of soil characteristics and qualities.
9. A computer printed soil classification table.

MONTANA ADP PROGRESS REPORT
January 1, 1974

1. McCone County Soil Survey Area, Montana was selected to test the applications of automated data processing (ADP) to an active soil survey. The following applications have been tested and evaluated.

   a. Mark sense forms were developed in Montana to encode pedon descriptions. (Examples attached.) There were 105 descriptions encoded by field soil scientists in the survey area during the pest year. The forms were mailed to the SCS state office and processed at Montana State University. The computer-written pedon descriptions were returned to the survey area. (Example attached.) The cost of the mark sense forms, processing the forms, end writing or storing the first pedon descriptions is summarized in Table 1. Corrections end/or additions to the descriptions are made on the cards punched by the document reader. This eliminated the first two costly steps shown in Table 1.

   b. Typifying pedons for 35 series in the survey area were selected end copies made by computer for the descriptive legends and soil survey handbooks. Cost to copy the stored descriptions using 3-part paper (one original and two carbons) was less then $.02 per pedon.

   C. Current lists of the series and their classification were prepared by computer for the survey area. The first list contained only the typifying pedons (Example attached). The second list contained all the pedons described in the survey area.

   Mark sense forms were developed to encode mapping unit data (Examples, Attached). These date are being encoded for the survey area and the programs to write the mapping unit descriptions (Example Attached) are being tested and revised.

   Computer programs were written to create the "Summary Table" of Soil Characteristics and Qualities". (Example Attached.) The data in this file will be compared with those data in the soil interpretation criteria tables to obtain the first approximation of the manuscript interpretation tables.

   Attached is a diagram of our proposed computerized system to process soil resource data. It shows the files of data needed. how they are to be created, and the objectives of the different files.

2. Accomplishments not related to McCone County Soil Survey are as follows:

   a. There were 186 Montana pedons encoded using the 1968 proposed coding system for the pedon data record for the National Cooperative Soil survey. They have been updated end reformatted to conform with the present pedon data subsystem. These data were delivered to Washington, C.C. on magnetic tape the week of May 28, 1973. '

b. The soil pedon description program was revised to write the description from data in the pedon data subsystem.

c. A soil classification file for Montana series was developed. A record of series correlations end series dropped fro,,, the Montana list is kept and printed out for reference.

d. All the pedon descriptions and laboratory data for Montana soil characterization data are stored on magnetic tape. These data will be reproduced by computer nnd sent to the field soil scientists this winter.

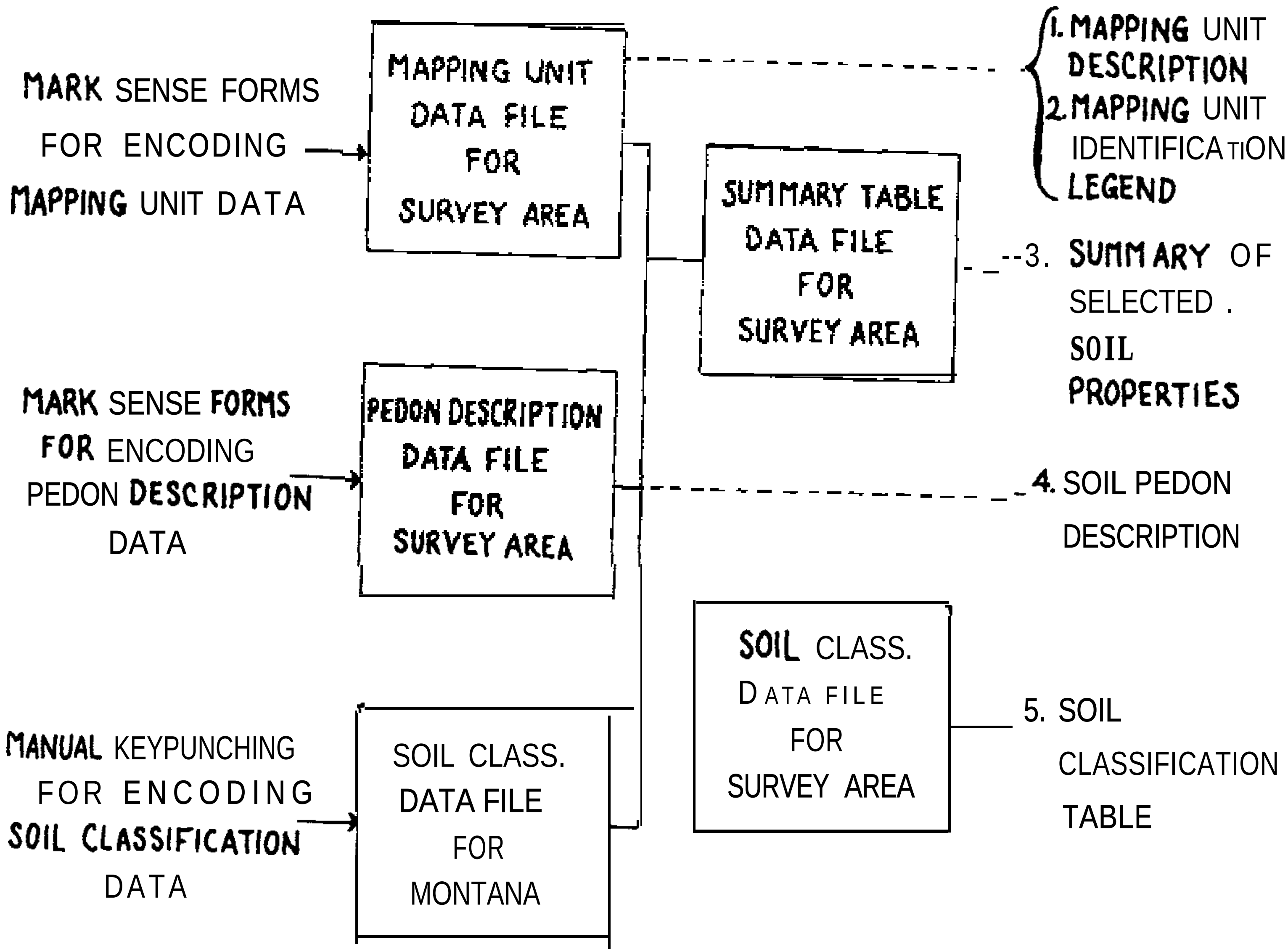
e. Statistical relationships between field soil properties ond available water-holding capacity have been studied, plotted, and used to establish Montana guidelines for estimating plant available water.

Table 1. Cost cf the mark sense forms, processing the forms, and writing the pedon description for an average t-horizon pedon.

	Pedon
Mark Sense Forms (Average 13 forms/ average pedon @ 0.022) 13 x 0.022=0.29	0.29
IRE, Document Reader (Average 500 forms/ hour @ $10.00/hour) 13/500 x 10.00=	0.26
Sigma 7 (Print or store a pedon description)	0.15*
TOTAL COST (Forms and Machine)	0.70
Student labor to process the mark sense forms (Average 10 pedons/hour @ $3.00 (hour)	0.30
TOTAL COST	$1.00

*Test T"" on 10 pedons cost $1.45.

One of the students hired by Montana State University to work on ADP received the mark sense forms, key punched cards for series name, classification, and location and cards for remarks; inserted these into the deck from the document reader; submitted the job to the Sigma 7; and returned the computer printouts to the field.


MARK SENSE FORMS FOR ENCODING MAPPING UNIT DATA
MAPPING UNIT DATA FILE FOR SURVEY AREA
1. MAPPING UNIT DESCRIPTION
2. MAPPING UNIT IDENTIFICATION LEGEND
SUMMARY TABLE DATA FILE FOR SURVEY AREA
3. SUMMARY OF SELECTED . SOIL PROPERTIES
MARK SENSE FORMS FOR ENCODING PEDON DESCRIPTION DATA
PEDON DESCRIPTION DATA FILE FOR SURVEY AREA
4. SOIL PEDON DESCRIPTION
SOIL CLASS. DATA FILE FOR SURVEY AREA
5. SOIL CLASSIFICATION TABLE
MANUAL KEYPUNCHING FOR ENCODING SOIL CLASSIFICATION DATA
SOIL CLASS. DATA FILE FOR MONTANA

INSTRUCTIONS
FOR
ENCODING SOIL MORPHOLOGICAL DATA

I. GENERAL INFORMATION

Mark sense forms for encoding soil morphological date have been developed in Montana.

Soil data headings, subheadings, and alpha/numeric codes were over-printed on blank IBM 529 forms by SCS Cartographic Unit in Portland. The codes were taken from and are completely described in the "Pedon Coding System for the National Cooperative Soil Survey." A condensed version of the codes found on the mark sense forms are enclosed for use in your survey area.

The codes are selected and marked on the form with a 2H lead pencil. The mark sense forms are fed into a mark sense reading machine, and 80-column data cards are automatically punched.

The machine punched cards are combined with the manually punched cards which contain series name, location and remarks. The combined deck is submitted to the computer and morphological descriptions written.

A field for identification "LOCATION" is included on each mark sense form and includes the "county" and "site" number. The county number is the same one used when developing a soil sample number, i.e. 73-MONT-28-1.

II. ENCODING ENVIRONMENTAL AND/OR SITE DATA

The mark sense form illustrated by figure 1 includes the codes required for encoding data that is common to the entire pedon. This form is filled out once for the pedon. It also includes the series name, location, and special remarks that cannot be coded. This information is manually punched on cards. The sample number and classification are no longer needed on the form.

EXAMPLES :

1. If the vegetation is native grasses and forbs,
   --Under the major heading "VEG"
     --Mark the code "G"

2. If the physiography is a stream terrace,
   --Under the major heading "PHY"
     --Mark the code "ST"

3. If the parent material is alluvium from mixed sources,
--Under the major heading "PARENT MATERIAL"
--Mark the code "A" under subheading "Mode"
--Mark the codes "Y" and "3" under subheading "Origin"

NOTE: The "Bedding inclination" codes are:
H - Horizontal
I - Inclined

III. ENCODING HORIZON DATA

Figures 2, 3, and 4 illustrate the kind of data and codes used for encoding the data for one horizon of a morphological description. The mark sense form illustrated by figure 2 is always used while the forms illustrated by figures 3 and 4 may or may not be used, depending on the kind and amount of data available.

Another set of one, two, or three mark sense forms are filled out for each horizon.

NOTE: The horizon number ("HOR. NO.") and page ("PAGE") number following the "SITE LOCATION" have to be marked on each mark sense form.

EXAMPLES:

1. If the horizon designation is.

a. B22t
--Under the major heading "HORIZON DESIGNATION"
--Mark the code "B" under subheading "Capitol"
--Mark the number "22" under subheading "Arabic"
--Mark the code "T" under subheading "Lower Case"

b. Ap2
--Under the major heading "HORIZON DESIGNATION"
--Mark the code "A" under subheading "Capitol"
--Mark the code "P2" under subheading "Lower Case"

2. If the soil color is (10YR 3/2, crushed) moist,
--Under the major heading "SOIL COLOR"
--Mark the code "3" under subheading "Location"
--Mark the code "M" under subheading "Moisture"
--Mark the codes "10" and "YR" under subheading "Hue"
--Mark the code "3" under subheading "Value"
--Mark the code "2" under subheading "Chroma"

3. If texture is,

a. Very fine 'sandy loam (vfsl)
--Under the major heading "HORIZON TEXTURE"
--Mark the codes "VF," "S" and "L"

b. Loam (1)
--Under the major heading "HORIZON TEXTURE"
--Mark the code "L"

c. Silt loam (sil)
--under the major heading "HORIZON TEXTURE"
--Mark the codes "Si" and "L"

NOTE: The texture "loamy fine sand (lfs)" has to be marked "F" snd "LS"
Loamy very fine sand is marked "VF" and "LS"

IV. OTHER NOTES

1. Soil and Air temperatures are coded in degrees F.

2. <u>Elevation</u> and <u>horizon limits</u> are recorded in meters and centimeters respectively. <u>Precipitation</u>, <u>depths</u>, and <u>thickness</u> are also recorded in centimeters.

3. Major heading "STRUCTURE" end subheading "Relationship." If one structure breaks or separates into another, mark either the "2" or the "3" code.

4. Major headings "N NOTE," "SP NOTE," "C NOTE," or "CF NOTE." The "Abund" subheading for nodules, soil pores, cutans, and coarse fragments may be recorded as a letter (i.e. few, common, etc.) or a percent. If you want to use percent, you have to mark the code "P" in the respective "NOTE" column.

5. Major heading "HORIZON LIMITS" on page 3 (Fig. 4) refers to the horizon thickness range. This is the data printed in parentheses behind the horizon boundary and usually not used.

6. Major heading "NO. of HOR." in figure 1 refers to the number of horizons you will be describing for the pedon.

CODES

FOR

MARK SENSE FORMS

USDA-SCS-MONT AUGUST 1973

SLOPE

Kind:

P - plane
V - concave
X - convex
I - irregular

Microrelief:

C - cradle knolls
F - frost polygons
G - gilgae
M - mounds

C - closed depressions
N - forms a net
L - forms a linear pattern

H - on crest of high point
S - on slope
D - in depression
0 - on crest and slopes
X - on slope and depression

Class:

A - level
B - gently sloping
C - moderately sloping
D - strongly sloping
E - moderately steep
F - steep
G - very steep

VEGETATION

C - crops, dryland
I! - crops, irrigated
G - grasses and forbs
A - grasses, forbs and shrubs
S - shrubs
F - forest, unspecified

DRAINAGE

1 - very poorly
2 - poorly
3 - somewhat poorly
4 - moderately well
5 - well
5 - somewhat excessively
7 - excessively
8 - altered, drained
9 - altered, wetted

PERMEABILITY

1 - very slow
2 - slow
3 - moderately slow
4 - moderate
5 - moderately rapid
6 - rapid
7 - very rapid

STONINESS

1 - class 0
2 - class 1
3 - class 2
4 - class 3
5 - class 4
6 - class 5

PHYSIOGRAPHY

B - basins, playas and old lake beds
BI - basins, interior drainage
BX - basins, exterior drainage
ST - stream terraces, outwash terraces, and plains terraces
LU - level and undulating uplands
RU - rolling and hilly uplands
M - mountains, steep hills
SD - sand dunes and sand hills
FP - flood plains
SM - swamps and marshes, includes wet coastal lowlands
F - fans, both alluvial and colluvial

PARENT MATERIAL

Mode:

E - eolian, mixed
H - eolian, ash
W - eolian, loess
S - eolian, sand
D - glacial drift
G - glacial outwash
T - glacial till
L - lacustrine
El - marine
X - residual material, local colluvium
R - solid rock
U - unconsolidated mineral sediments
A - alluvium
O - organic sediments

Origin:

AO - sandstone, unspec.
Al - noncalcareous
A2 - arkosic
A3 - other noncalcareous
A4 - calcareous

BO - interbedded, unspec.
El - limestone, sandstone, & shale, w/wo siltstone
B2 - limestone and sandstone
B3 - limestone and shale
B4 - limestone and siltstone
B5 - sandstone and shale
B6 - sandstone and siltstone
B7 - shale and siltstone

PARENT MATERIAL (Cont'd)

Origin (Cont'd) :

HO - shale, unspec.
H1 - noncalcareous
H2 - calcareous
H3 - siltstone, unspec.
114 - noncalcareous
H5 - calcareous

I0 - igneous rocks, unspec.
I1 - coarse (or intrusive), unspec.
I2 - basic (including gabbro, nepheline rocks, peridotite, etc.)
I3 - intermediate (including granodiorite, monzonite, tonalite, diorite, etc.)
I4 - acid (including granite, etc.)
I5 - fine (or extrusive), unspec.
I6 - basic (including basalt, etc.)
I7 - intermediate (including andesite, etc.)
I8 - acid (including rhyolite, trachyte, etc.

L0 - limestone, either unspec. or calcitic
L1 - chalk
L2 - marble
I.? - dolomitic
1.4 - phosphatic
L5 - arenaceous (sandy)
L6 - argillaceous (shaly)
L7 - cherty

CONSISTENCE:

11 - nonsticky
12 - Slightly
13 - sticky
14 - very

21 - nonplastic
22 - slightly
23 - plastic
24 - wry

31 - slightly
32 - Thixotropix
33 - very

41 - loose
42 - very friable
43 - friable
44 - firm
45 - very firm
46 - extremely

51 - slightly
52 - brittle
53 - very

61 - loose
62 - soft
63 - slightly hard
64 - hard
65 - very
66 - extremely

71 - weakly cemented
72 - strongly cemented
73 - indurated

81 - slightly compact
82 - moderately compact
83 - very compact

STRUCTURE:

Grade:

1 - very weak
2 - weak
3 - weak to moderate
4 - moderate
5 - moderate to strong
6 - strong

Type:

PL - platy
LP - lenticular platy
PR - prismatic
COL - columnar
ABK - angular blocky or blocky
SBK - subangular blocky
GR - granular
CR - crumb
MA - massive
SGR - single grain
WEG - wedge
CDY - cloddy

NODULES

Kind:

BA - barite
DU - durinodes
GY - gypsum
IC - insect casts
IM - iron-manganese
LI - lime
LS - lime-silica
MS - magnetic shot
NS - nonmagnetic shot
OS - oxides
PE - pedotubules
PL - plinthite
SA - salts
UK - unknown
WC - worm casts

pH

Method:

B - Bromthymol blue
C - Cresol red
H - Hellige-Truogg
L - Lamott-Morgan
M - pH meter
P - Phenol red
S - Soiltex
T - Thymol blue
Y - Phydrion

St%:

VA - very strongly acid
SA - strongly acid
MA - medium acid
LA - slightly acid
NE - neutral
IK - mildly alkaline
OK - moderately alkaline
SK - strongly alkaline
VK - very strongly alkaline

EFFERVESCENCE

N - very slightly or noncalcareous
S - slightly or mildly
M - strongly or moderately
V - violently

H - HCL
I - HCL 1N
P - H_2O_2
Q - H_2O_2--3%

ROOTS

Location:

C - in cracks
M - in mat at top of ref. horizon
P - between peds
S - matted

CUTANS

Kind:

U - unknown
A - skeletans over cutans
C - chalcedony or opal
G - gibbsite
L - lime or carbonates
M - manganese
O - organic
S - skeletans
1 - clayskins (waxlike)
X - shiny, grooved pressure faces (slickensides)
Y - shiny, not grooved pressure faces (slickensides)
Z - not shiny, not grooved pressure faces
R - unstained sand grains
E - stained sand grains

Location:

T - throughout the soil
J - in root channels and/or pores
P - on ped faces
H - on horizontal ped faces
V - on vertical ped faces (prisms)
Z - on horizontal and vertical ped faces
B - as bridges between sand grains
S - on sand and gravel
U - on upper surfaces of peds or stones
L - on lower surfaces
C - on tops of columns
M - on bottom of plates
C - on undersides of coarse fragments
A - around coarse fragments

COARSE FRAGMENTS

Kind:

K - lignite
C - chert
D - dolomite
G - granite
H - shale
P - pumice and/or cinder
W - weathered sedimentary rock
O - oxide protected rock
I - [redacted]
[redacted]

[redacted]

COARSE FRAGMENTS (Cont'd)

Size:

1 - > 2 mm	6 - 20-80 mm
2 - > 20 mm	7 - 50-250 mm
3 - > 8 cm	8 - 2-80 mm
4 - > 25 cm	9 - 2-250 mm
5 - 2-20 mm	

ABUNDANCE

P - present
F - few
FC - few to common
C - common
CM - common to many
M - many or continuous

SIZE

UF - ultra fine
MV - micro to very fine
VF - very fine
FF - very fine to fine
F - fine
FM - fine to medium
M - medium
MC - medium to coarse
C - coarse
MM - micro to medium
FC - fine to coarse

NOTE

I, - letter
P - percent

LAMELLAE

C - charcoal bands
K - krotovina
L - lime
M - manganese
O - organic lamellae
S - stoneline
V - varves
X - stratifications
B - bands

CONTRAST

F - faint
D - distinct
P - prominent
V - very prominent

CEMENTING AGENT

[redacted]
[redacted] - iron
[redacted]
[redacted] and silica

SERIES

SAMPLE NUMBER

CLASSIFICATION

LOCATION

REMARKS

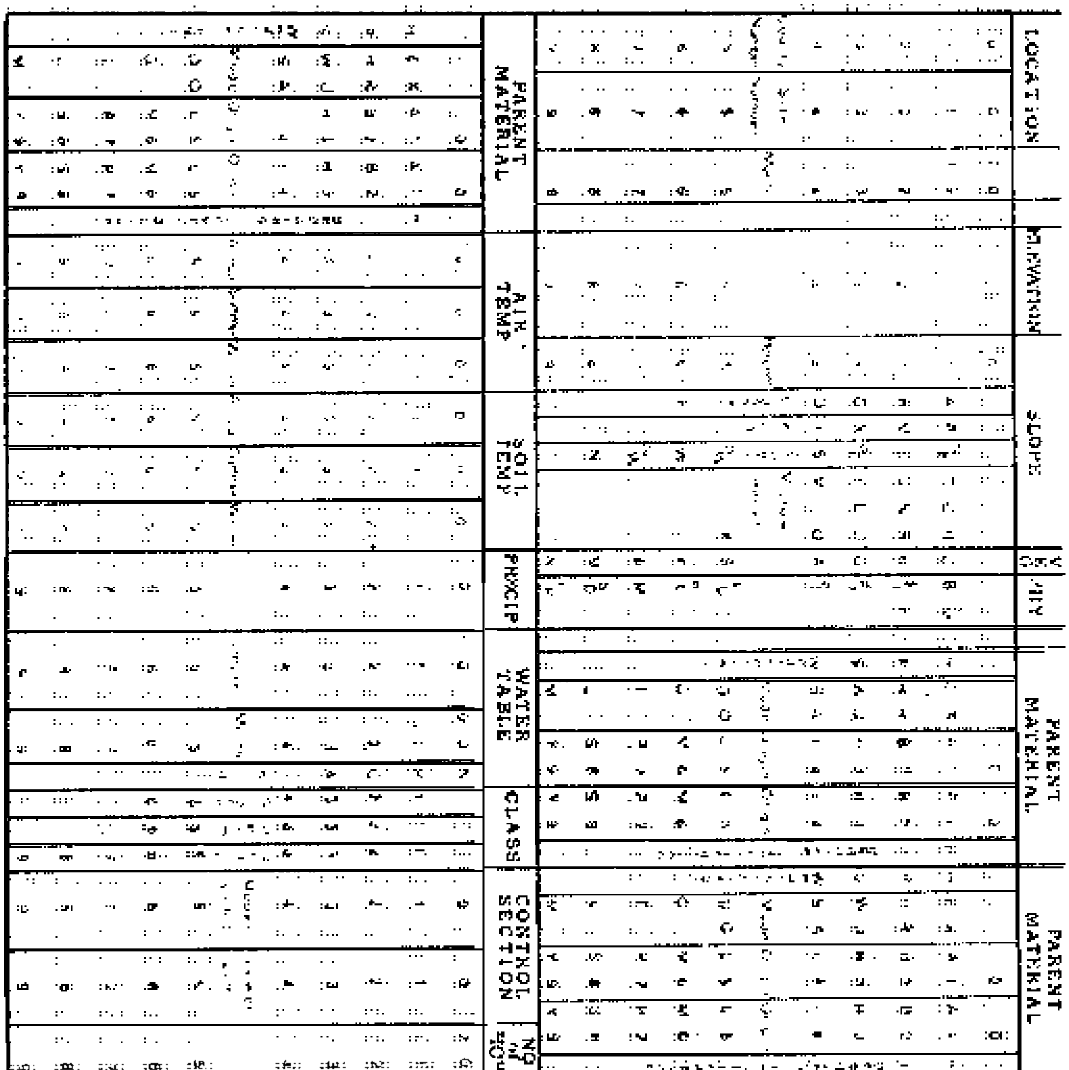


Figure 1

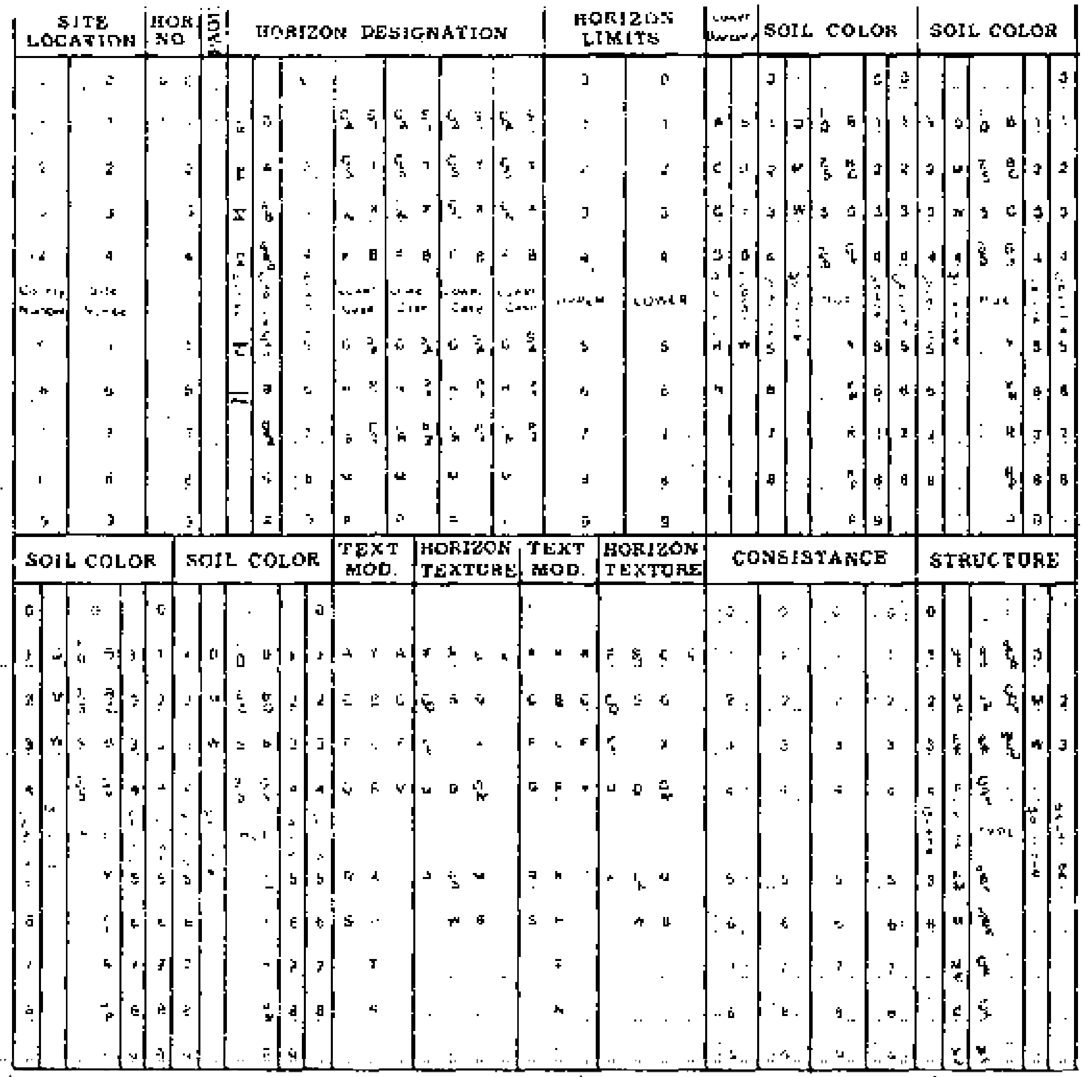

SITE LOCATION
HOR NO
HORIZON DESIGNATION
HORIZON LIMITS
SOIL COLOR
SOIL COLOR
SOIL COLOR
SOIL COLOR
TEXT MOD.
HORIZON TEXTURE
TEXT MOD.
HORIZON TEXTURE
CONSISTANCE
STRUCTURE

Figure 2

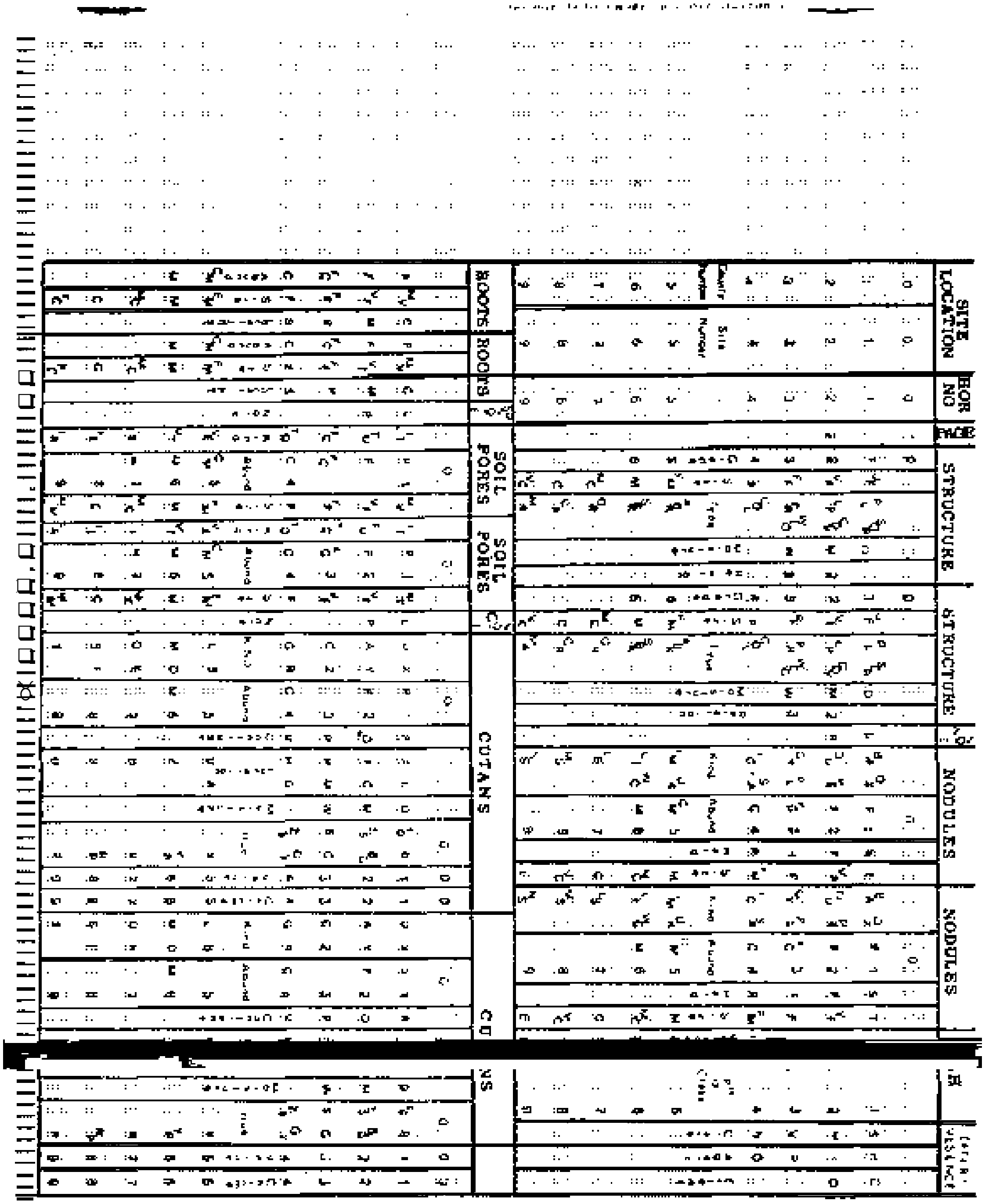

SITE LOCATION
HOR NO
PAGE
STRUCTURE
NODULES
ROOTS
SOIL PORES
CUTANS

Figure 3

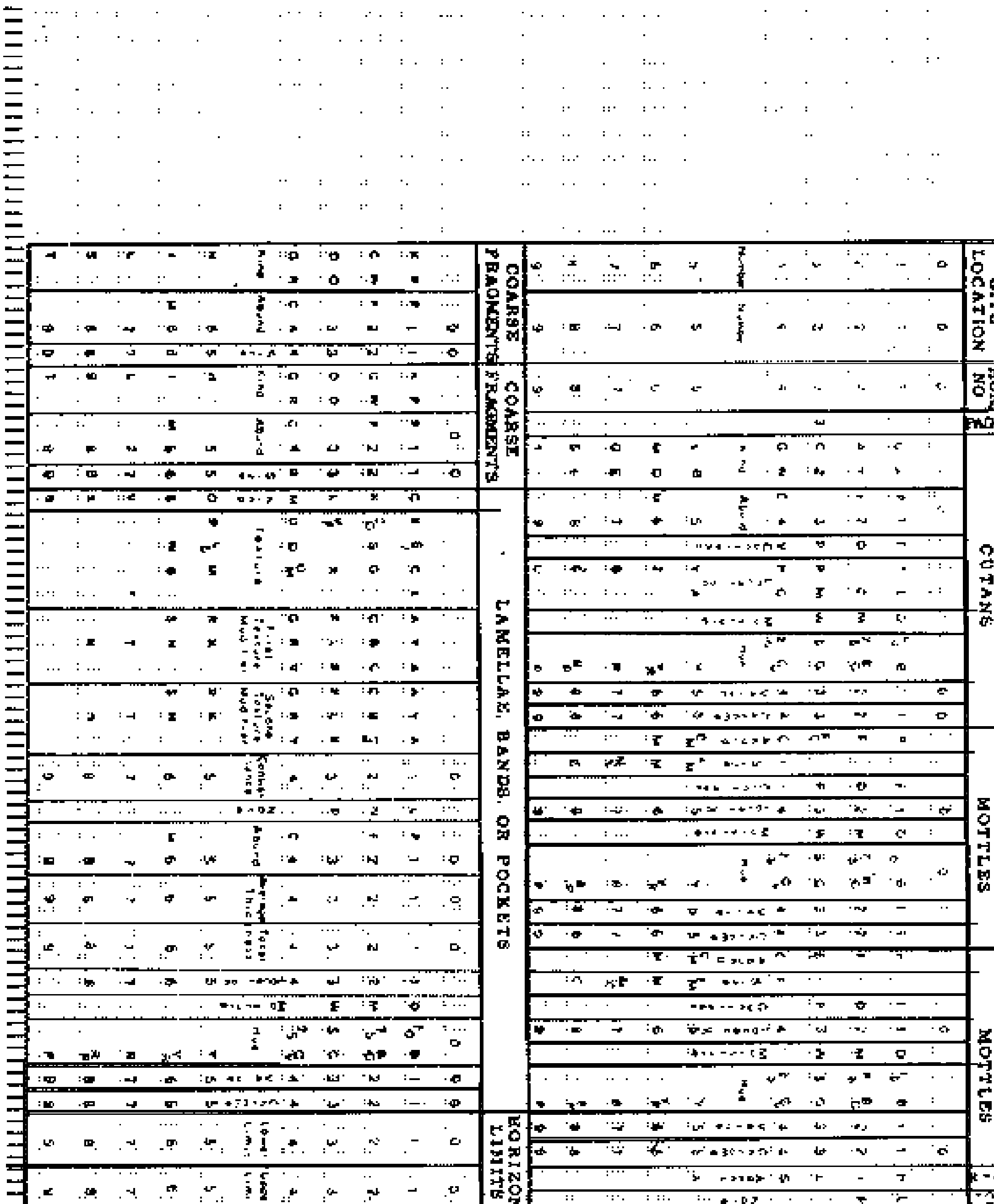

SITE LOCATION
HOR. NO
COARSE FRAGMENTS
COARSE FRAGMENTS
CUTANS
LAMELLAE, BANDS, OR POCKETS
MOTTLES
MOTTLES
HORIZON LIMITS

Figure 4

SOIL SERIES: LAMBETH

SURVEY SAMPLE NO.:

LOCATION:	200 FEET NORTH, 300 FEET NEST OF SOUTHEAST SEC. CORNER OF SEC. 7, T18N, R44E		
CLASSIFICATION:	USTIC TORRIORTHENTS; FINE-SILTY , MIXED (CALCAREOUS) , FRIGID		
SITE NUMBER: 11	COUNT", MCCONE	ELEVATION: X.0 METERS	MONTH SAMPLED: AUGUST
SLOPE: 1X	CLASS! LEVEL	KIND: PLANE	ASPECT:
PRECIPITATION:	CM	CONTROL SECTION LIMITS --	UPPER: 25 CM LOWER: 100
PERMEABILITY:	SLOW	DRAINAGE CLASS: WELL DRAINED	
PHYSIOGRAPHY:	STREAM, OUTWASH OR PLAINS TERRACES		STONINESS: CLASS 0
VEGETATION:	GRASSES AND FORBS		
PARENT MATERIAL:	ALLUVIUM CALCAREOUS SILTSTONE		

A 1 — 0 - 10 CM. (0 - 4 INCHES)

LIGHT BROWNISH GRAY (10YR 6/2) CRUSHED DRY PEDS *** DARK GRAYISH BROWN (10YR 4/2) CRUSHED MOIST PEDS *** SILT LOAM *** MODERATE FINE GRANULAR STRUCTURE *** SOFT ... VERY FRIABLE ... SLIGHTLY STICKY ... SLIGHTLY PLASTIC *** "(*NT FINE & MEDIUM "DO,, THROUGHOUT HORIZON ... COMMON TO MANY FINE & MEDIUM TUBULAR CONTINUOUS PORES *** MILDLY EFFERVESCENT (HCL) *** CLEAR WAVY BOUNDARY ***

C 1 — 10 - 35 CM. (4 . 14 INCHES)

LIGHT GRAY (10YR 7/2) CRUSHED DRY PEDS ● +m GRAYISHBROWN (10YR 5/2) EXTERIOR OF MOIST PEDS *** SILT LOAM *** MODERATE MEDIUM PRISMATIC STRUCTURE *** HARD ... FRIABLE ... STICKY ... PLASTIC *** COMMON TO MANY FINE ROOTS THROUGHOUT HORIZON ... COMMON TO MANY FINE TUBULAR CONTINUOUS CORES ● ** VIOLENTLY EFFERVESCENT (HCL) ● 1 GRADUAL SMOOTH BOUNDARY ***

C 2 — 35 - 150 CM. (14 . 59 INCHES)

LT.

REMARKS:

MAPPING UNIT

REMARKS

MAPPING UNIT	SLOPE PERCENT	COARSE FRAG	COARSE FRAG	LAND CAPABILITY	LAND CAPABILITY	RUN OFF	EROSION	PHY	RELIEF

FIRST TAXONOMIC UNIT

SECOND TAXONOMIC UNIT OR AN INCLUSION

MAPPING UNIT			INCLUSION PHASES					THIRD TAXONOMIC UNIT OR AN INCLUSION								
1	A		1	1	1	1		1	1	A B A	P S_1 C L	1	1	R	B	Y
2	B	2	2	2	2	2		2	2	B H C	C_o S G E	2	2	S	C_H	S
3	C		3	3	3	3		3	3	C K F	V_F I X K	3	3	D	S_H	
4	D		4	4	4	4		4	4	F L V	U D Q_M T	4	4	F	S_T	
Number	Class	Phase	2^{nd}	3^{rd}	4^{th}	5^{th}		Site Number	% Comp	Surface Modifier	Surface Texture	Lower Slope	Upper Slope	[illegible]	Phys 1^{st} 2^{nd}	[illegible]
5	E		5	5	5	5		5	5	G N	P L_S M P	5	5	W	F	
6	F		6	6	6	6		6	6	M R	H W B	6	6	L	S_D	
7	G		7	7	7	7		7	7	P T	L A R	7	7	U	F_P	
8			8	8	8	8		8	8	S Y	M U C	8	8			
9			9	9	9	9		9	9		E A	9	9			

FORTH TAXONOMIC UNIT OR AN INCLUSION									FIFTH TAXONOMIC UNIT OR AN INCLUSION								
1	1	A B A	P S_1 C L	1	1	R	B	Y	1	1	A B A	P S_1 C L	1	1	R	B	Y
2	2	B H C	C_o S G E	2	2	S	C_H	S	2	2	B H C	C_o S G E	2	2	S	C_H	S
3	3	C K F	V_F I X K	3	3	D	S_H		3	3	C K F	V_F I X K	3	3	D	S_H	
4	4	F L V	U D Q_M T	4	4	F	S_T		4	4	F L V	U D Q_M T	4	4	F	S_T	
Site Number	% Comp	Surface Modifier	Surface Texture	Lower Slope	Upper Slope	[illegible]	Phys 1^{st} 2^{nd}	[illegible]	Site Number	% Comp	Surface Modifier	Surface Texture	Lower Slope	Upper Slope	[illegible]	Phys 1^{st} 2^{nd}	[illegible]
5	5	G N	P L_S M P	5	5	W	F		5	5	G N	P L_S M P	5	5	W	F	
6	6	M R	H W B	6	6	L	S_D		6	6	M R	H W B	6	6	L	S_D	
7	7	P T	L A R	7	7	U	F_P		7	7	P T	L A R	7	7	U	F_P	
8	8	S Y	M U C	8	8				8	8	S Y	M U C	8	8			
9	9		E A	9	9				9	9		E A	9	9			

BENZ CLAY LOAM , 0 TO 8 PERCENT SLOPES (53)

THIS NEARLY LEVEL TO MODERATELY SLOPING SOIL OCCUPIES ALLUVIAL FANS AND STREAM TERRACES IN THE UPLANDS. IT HAS THE PROFILE DESCRIBED AS TYPICAL FOR THE SERIES. INCLUDED IN MAPPING ARE A FEW SMALL AREAS OF HAYRELON , YANDA AND TREMBLES SOILS.

SURFACE RUNOFF IS SLOW OR MEDIUM AND THE EROSION HAZARD IS SEVERE FROM WIND AND WATER.

SUMMARY DATA

S[redacted]EMBLES — MAPPING UNIT: 171

SURFACE TEXTURE: FINE SANDY LOAM	SLOPE: 0 TO 4 PERCENT
LAND CAPABILITY (NK) DRYLAND: 4W1 IRRIGATED	PERMEABILITY: MODERATELY RAPID
DRAINAGE: WELL	FLOOD HAZARD: 2
AVAILABLE WATER HOLDING CAPACITY: 20 CM.	ROCKINESS: CLASS 0
SURFACE COARSE FRAGMENTS: _ TO _ PERCENT.	STONINESS: CLASS 1
SURFACE RUNOFF: SLOW	SOLUM THICKNESS: 40 CM.
EROSION HAZARD FROM WIND: SEVERE	DEPTH TO BEDROCK: CM.
EROSION HAZARD FROM WATER: SEVERE	DEPTH OF SOIL: 150 CM.
PHYSIOGRAPHY: FLOOD PLAINS AND STREAM TERRACES	WATER TABLE: CM.

CLASSIFICATION OF SOIL SERIES
MC CONE COUNTY
AUG, 1973

	ABSHER	2	BOROLLIC	NATRARGIDS;	FINE , MONTMORILLONITIC
	[redacted]	2	BOROLLIC	NATRARGIDS;	FINE-LOAMY , MIXED
	BADLANDS	3			
	BANKS	2	TYPIC	USTIFLUVENTS;	SANDY , MIXED , FRIGID
	BEAVERTON	3	TYPIC	ARGIBOROLLS;	LOAMY-SKELETAL , MIXED
	BENZ	2	USTIC	TORRIFLUVENTS;	FINE-LOAMY , MIXED (CALCAREOUS) , FRIGID
	BLANCHARD	3	TYPIC	USTIPSAMMENTS;	, MIXED , FRIGID
	BOWBELLS	3	PACHIC	ARGIBOROLLS;	FINE-LOAMY , MIXED
	BOWDOIN	2	USTERTIC	TORRIFLUVENTS;	VERY FINE , MONTMORILLONITIC (CALCAREOUS) ,
	BRANDENBURG	3	LITHIC	USTORTHENTS;	LOAMY-SKELETAL , MIXED (CALCAREOUS) , FRIGID
T	BRUSSETT	3	ARIDIC	ARGIBOROLLS;	FINE-SILTY , MIXED
	CHAMA	2	TYPIC	HAPLOBOROLLS;	FINE-SILTY , MIXED
	CHINOOK	2	ARIDIC	HAPLOBOROLLS;	COARSE-LOAMY , MIXED
	DIMMICK	2	VERTIC	HAPLAQUOLLS;	FINE , MONTMORILLONITIC , FRIGID
	DIMYAW	2	TYPIC	USTORTHENTS;	FINE , MONTMORILLONITIC (CALCAREOUS) , FRIGID
	ETHRIDGE	3	ARIDIC	ARGIBOROLLS;	FINE , MONTMORILLONITIC
	FARLAND	2	TYPIC	ARGIBOROLLS;	FINE-SILTY , MIXED
	FARNUF	2	TYPIC	ARGIBOROLLS;	FINE-LOAMY , MIXED
T	FLOWEREE	,	ARIDIC	HAPLOBOROLLS;	
	HARLEM	2	USTIC		
	HAWKSELL	,	USTIC		
T	HOFFMANVILLE	4	TYPIC		
1	KOBAR	2			
	LAMBERT	2	--		FINE-SILTY FRIGID
	LIHEN	2	ENTIC		SANDY ,
	LISAM	2	USTIC		FRIGID , SHALLOW
	LONEPINE	3	TOROLLIC		
T	RAPELJE	2			
	REGENT	2			
T	RIDGELAWN	3			
	RIVERWASH	3			
	SANDSTONE OUTCROP	5			
	SAVAGE	2			

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

San Diego, California - January 21-25, 1974

Report of Committee 2
Modernizing Soil Survey Publications

The committee, rather than addressing itself to the specific charges, developed recommendations related to the content and format of soil survey publications, to interim and special reports, and to procedures. Each of these subject areas is discussed individually.

This report is an attempt to reconcile the many differences and opinions offered during the on-floor conference discussion of the committees draft report.

I. Contents of Standard Soil Survey Publications:

1. Individual States should be given the option of including detailed criteria in the soil survey publication, as determined by local needs and conditions. Exceptions to National criteria should be permitted to meet unique local conditions or problems. These deviations from National criteria should be explained in the publication. If criteria are included they should be dated.

2. States should have the option of including soil interpretation limitations - that is, they should, based on local ordinances, be able to discuss applicable uses of interpretations, if desired.

3. Where applicable (e.g. - order 3 or 4 surveys) both taxonomic and cartographic detail should be explained, the levels or orders used - if more than one - described, and the limits or effects on uses given. There is a need for identifying differences in mapping intensities within a given survey area, so users will better understand the survey. Users need to know the limits - or degree of detail - for each intensity of survey, for the different map unit designs, for differences in map scale, and for the detail, or intensity of the field work.

4. In order to accomplish item 3. above, guidelines need to be developed for explaining different survey orders. Further, since the needs of users of different orders of surveys may vary greatly, guidelines are also needed for the type of information or data to be presented, and the level of generalization or detail to be used.

5. The soil genesis and classification sections need to be written to reflect local conditions. This is existing policy, but is not followed as closely as it should - or could.

6. More illustrative and explanatory soil landscape photos, photos of morphological features, and landscape - soil diagrams should be used. Landscape-soil-vegetation-diagrams covering a cross section of a County or part of a County should be permitted if requested by a State.

7. More varieties of "graphics" should be approved at a State's option.

8. States should be given the option of dropping "Interpretive Groups." Such an option could be based on the type of survey, uses of the survey, or number of mapping units in a survey.

9. States should have the option of describing the inter-relations of the physical and chemical soil properties, kinds of soil horizons and their morphological features, and their significance locally.

10. States should have the option of deleting the estimated particle size distribution and the Atterburg limits from the engineering section.

11. Interpretations now required in NCSS publications but not applicable to a given area or county should not be included in the publication, at the State's option. This includes land capability.

II. Standard Soil Survey Publication Format.

1. If locally desired, soil survey publications should be printed in one, two or three parts, e.g.:

   (a) A single volume including interpretations and bound maps - present form.

   (b) Two volumes, one of technical text and bound maps, a second of interpretations.

   (c) Three volumes, one of technical text, a second of bound maps, and a third of interpretations.

   (d) Two volumes, one of technical text, a second of interpretations, and an envelope of loose maps (which can be lost or disordered).

   (e) One volume of technical text and interpretations, a limited number with bound maps. The remainder would contain no detailed soil maps, but individual maps would be available (either locally or through GPO) on request.

2. The table of contents should be expanded to show all subjects covered - including those now covered in the Guide to Mapping Units. As such it could serve as an organized index. Such a table should be at the option of States.

3. Map Unit Symbols should be permitted, as desired by individual States, to appear on the left margin of all tables, descriptions, or listings.

4. The States should have the option of a distinct method (e.g. - colored pages) of separating the technical text from the interpretative section.

5. Authors of Soil Survey manuscripts should have flexibility of writing with imagination, if desired, within a standard framework or format. Some uniformity of format throughout the State, Region, and Nation is desirable, especially for users of Soil Surveys throughout a State, Region, or the Nation. In other words, there should be flexibility of writing within a fixed framework.

6. General soil maps should be printed at a scale large enough to be interpreted for broad use planning - if desired by a given State.

7. Separate interpretations should be given for both the detailed mapping units, and general soil map units at the State's option.

8. The general soil map, if bound in the publication should be bound in the General Soil Map Section.

9. Keep maps, tables, and illustrations near the text that describes them.

10. In multi-taxa units the map unit descriptions should be expanded and clearly separated from the descriptions of the individual taxonomic units.

11. Thoughtful and early writing should be encouraged. Canned Statements with local editing should continue to be used.

12. Soil surveys should be written for the users. We need to review our audience in light of increased use by planners, engineers, and technically trained environmentalists.

13. A table showing relationships of soils, one to another, should be included at the State's option.

14. Glossaries should include most technical and vernacular terms in the publication.

15. The "how to use" section should give explicit, stepwise directions, reinforced by graphics.

16. General soil maps should be printed on an aerial photo base (or ERTS image) if desired by the State.

III. Interim Report.

As used in this report an interim report is one covering an entire area, or county (or at least the largest portion of an area or county) prior to the publication of a regular series report. A special report is one that 1) covers a part of an area or county and being developed for a specific reason, or 2) a report covering an area not scheduled for publication in the foreseeable future.

1. Interim reports should continue to be used, where needed.

2. Part of the justification for an interim or special report should be the willingness of the using agency to actively cooperate in writing, printing, and distributing it.

3. Interim reports should receive as careful and complete a technical review for readability and content by SCS-State and TSC offices and cooperating agencies as standard publications.

4. Special report, and in some instances interim report subject matter content and format should be flexible and designed to meet local needs and to allow testing of new formats or contents for future use in NCSS published soil surveys.

5. Legibility and design of interim and special report maps should be of as high a quality as possible.

6. Numbers of copies of interim or special reports should be determined by needs, and not necessarily limited to a set number based on printing limitations.

7. Colored interpretive maps should continue to be prepared, as needed, for interim or special reports, in cooperation with users.

8. Interpretations of multi-taxa units should be on a sliding-scale based on need

Addendum to Report of the Committee on - Modernizing Soil Survey Publications

The following are additional comments received on this report, from various conference members. They were not included in the report but are being included here for the information pur- [illegible]

of long standing. Any problems concerning which interpretations are applicable is usually a result of local disagreements."

Item II-5, delete.

Item II-6, delete."This option is available to States if the State will reimburse for added costs. It should be maintained on this basis."

Andrew A. Levin-USFS:

"I agree that States should be allowed to design reports that best fit the needs of their potential users."

Item I-4, we "definitely need to continue our support for better defining orders of soil surveys. The order approach has done a lot in determining what intensity of soil inventory is needed. Different orders of survey intensities should be allowed, within a survey area, as long as user is informed, as indicated in paragraph 3."

Item III, "Interim reports should be continued to be used (where needed) so that soil information can be given to users in a timely manner."

Dr. Frederick F. Peterson-UN-R:

Doesn't feel the committee should be continued unless new problems are raised by ADP report writing.

Ronald P. Bauer-USFS:

Item II-1b, "change 'should' to 'can.' General soil maps 'can' be printed on an aerial photo or ERTS image base. 'Should' implies that it has to be and excludes a planimetric base if this is what the State or agency needs."

Thomas W. Priest-SCS:

Item II-1-e, "I would not favor this proposal. I believe disadvantages of not having copies of the maps showing results of the survey available with each copy would far out weigh any advantage or savings by this proposal. I would delete this as a recommendation."

Carl W. Gurtney-SCS:

Item II-2, Add "The Guide to Mapping Units should be omitted at the State's option."

Robert F. Mitchel-SCS:

Item I-9, "I figure we have this option already."

Item III-3, "I'm not crazy about this one, but I won't fight it." The more reviews required the more the delays.

Item IV, Add "(1) The specialist responsible for technical accuracy should be assigned to work with the author before the final draft is written. All facts, inferences and evaluations should be checked or okeyed."

"(2) The editor responsible for editorial quality should be assigned to work with the author until the manuscript is far enough along to insure that no rewriting will be needed during editing."

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE

OF THE

COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA

JANUARY 21-25, 1974

Report of Committee 3

Waste Disposal on Land

The Conference Steering committee assigned the following charges to this committee:

1. Review the "Guide for rating limitations of soils for disposal of waste." Recommend any amendments, deletions or additions.

2. Establish the need for additional rating criteria for specific kinds of waste and develop guidelines.

3. Asses state pilot projects such as the project in Oregon and make summary available to conference.

Following is a summary of comments and recommendations on the three charges received from committee members.

Charge I - Re. Guide for rating limitations of soils for disposal of waste.

Table 1: Use following to replace Soil Drainage Class criteria:

Depth to Seasonal Water Table (1 month or more)	Slight	Moderate	Severe
	40"	20-40"	20"

In Table 1, the Sodium Absorption Ratio of the effluent being applied needs to be considered for the influence of this factor on infiltration rate. The table should reflect combined influence of the texture or base exchange capacity of the surface horizon.

Flooding should be expressed in terms defined for Form SCS-Soils-5.

Rather than designate mesic soils as having a moderate limitation several states would prefer that mesic soils with long growing seasons be designated slight.

The infiltration rate needs better definition before it can be used consistently. Past use or treatment of soils strongly influence infiltration rates.

Table 2:

Consideration for wind erosion hazard is pertinent to the disposal of some solid waste in soil to avoid nuisance. Same reference to Footnote 1 as for Table 1.

On page 11 add the following sentence before the last two sentences on the page. "The trace element content of the soil should be examined after a few decades of use of the site for waste disposal. Eventually, the site may need to be abandoned or trace element levels will reach toxic levels. This should be considered in the initial plans for the operation."

A few errors noted are:

Page 2, line 14	Other than BOD. The best soil...
Page 9, line 6	Tables 4 and 7 (pages 23 and 26) list...
Page 17, line 16	Spelling error - Element not elemtn.

/

Charge 2 - Re. Need for additional rating criteria for specific kinds of waste.

1. Disposal of waste from paper mills.

2. Use of constant input approach to calculate yearly N mineralization in disposal area. See Appendix 1.

Charge 3 - Re. Assess State Pilot Projects.

The ARS Water Laboratory in Phoenix has been involved in a study of applying municipal sewage from the city of Phoenix to soils and alluvial deposits as a potential means of sewage disposal. This project, known as the "Flushing Meadows Project" was started in 1967. The use of a plant-soil filter system (grass recharge basins) shows potential for converting secondary effluent into water satisfactory for irrigation, recreation, and even human domestic use under the right conditions.

A study was recently completed at the University of Arizona to determine the feasibility of exchanging sewage effluent from the city of Tucson for groundwater from the Avra Valley. The treated wastewater would be used for irrigation in the Avra Valley and the high quality groundwater would be added to the Tucson municipal system for domestic use.

Committee -

John M. Allen, Chairman	
C. W. Gurnsey	D. M. Hendricks
Tom Priest	E. M. Richlen
L. L. Joos	W. D. Nettleton
R. C. Singleton	L. N. Langan
H. A. Fosberg	L. A. Bates

USING ORGANIC WASTES A$ NITROGEN FERTILIZERS

P. F. PRATT

F. E. BROADBENT

J. P. MARTIN

EVEN THOUGH ORGANIC WASTES have been used as sources of nutrient elements for many centuries, a rational basis for their use has never been developed. Recommended rates have been based on experience and research planned without the ability to match application rates to the needs of crop plants, and with little information on the rate of biological decay of the organic materials.

Research on organic materials, particularly animal wastes, was popular previous to the availability of inexpensive inorganic N fertilizers following World War II. With a shift to the inexpensive inorganic N sources with their many advantages, the research on organics decreased. Interest and activity with organics has increased in the past 5 years largely as a result of the need for land disposal of large volumes of animal wastes. At present, the concern for animals wastes remains high, and in addition, interest in land disposal of municipal sludges has increased.

Field research presently underway with animal wastes and municipal sludges as sources of available N for plants is still based largely on experience. The usual approach is to add various amounts of wastes and to measure the amounts of N used by plants and the amounts of N in the soil in available and organic form. No theoretical basis for matching rates to crop needs has been proposed or tested for continued use over a period of years.

Agricultural land will be needed for disposal of wastes in the future. A scarcity of inorganic fertilizers may result from fuel shortages. In the future, organic sources of N will be needed to maintain optimum productian of food and fiber as the supply of inorganics decreases; and it will be necessary to avoid excesses of nitrates because of the way this ion moves into surface and ground. waters. These are some of the reasons for a rational approach to determining application rates of organics. This study proposes an approach which is consistent with these needs and with the tong. term use of organics as N sources.

Mineralization rates

Organically combined N must be mineralized before it can become available to plants. Thus. the rate of mineralization is the key to the rate of application of any given material. The yearly rates of mineralization are expressed as a series of fractional mineralizations of any given application, or the residual of that application. These ore referred to hereafter as a *decay series.* For example, the decay series, 0.30, 0.10, .05, means that for any given application, 30% is mineralized the first year, 10% of the residual (that which was not previously mineralized) is mineralized the second year, and 5% of the residual is mineralized the third and all subsequent years. The same series is applied individually to each yearly application of organic N.

With this decay series, if 100 lbs N were added per acre per year, the mineralized N the first year would be 30 lbs per acre, the second year it would he 30 lbs from the second application and 7 lbs from the first application (10% of the residual, which is 70 pounds) for a total of 37 pounds per acre. During the third gear the total N mineralized would be 30 ($.30 \times 100$) plus 7 (0.10×70) plus 3.2 (0.05×63) for a total of 40.2 lbs per acre. The total mineralization each year over a long period of time can be calculated in a similar fashion. Because these calculations become rather tedious, computer programs were developrd to handle a number of decay series in combination with various rates and times.

Constant input approach

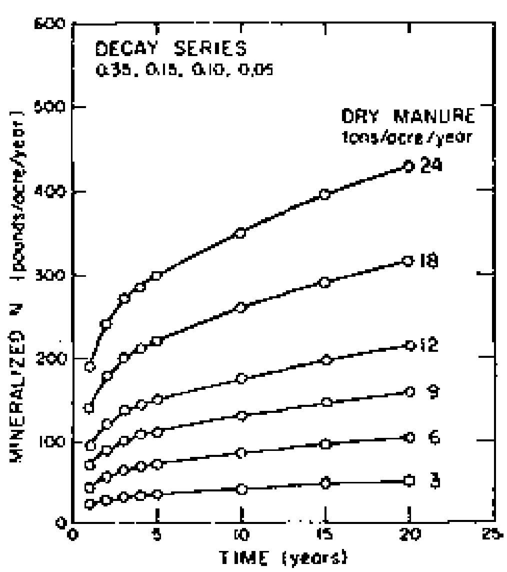
The objective of the "constant input approach is to calculate the expected yearly N mineralized for given combinations of decay series, and constant rates of annual application of organic material. A number of decay series were studied but only those which were judged to be appropriate for five animal waste materials and one municipal sludge were selected for this report. These wastes are under consideration for use on irrigated lands of California valleys where the seasons are hot and long and where the winter temperatures in the soil seldom decrease to a low enough level to stop microbial decomposition of organic residues. Thus, the end number in each series is 0.06 or 0.05—a relatively high final rate of mineralization of the residual organic N, as compared with that expected in colder climates.

N sources for a cropping system that needs 200 lbs of available N per acre per year, it would be necessary to add 24 tons the first year, and decrease the rate to less than 12 tons for the 20th year. If 24 tons were added continually, the requirements of the cropping system would be greatly exceeded after a few years. If 12 tons per acre were added per year as a constant rate of input the crops would be starved for a 15-year period before mineralization would be built up to the desired level.

Because of this gradual increase in yearly mineralization, as the residual organic N in the soil increases, constant rates of application of most organic N sources are not desirable. If a constant rate that will build up to the desired yearly mineralization is being used it can be supplemented with inorganic sources until the organic source can supply all that is needed.

The decay series 0.90, 0.10, and 0.05

GRAPH 1. YEARLY MINERALIZATION RATE IN RELATION TO TIME FOR VARIOUS CONSTANT RATES OF CORRAL MANURE HAVING 25% WATER AND 1.5% N ON A DRY WEIGHT BASIS.



GRAPH 2. YEARLY RATES OF APPLICATION OF MANURE, CONTAINING 25% WATER AND 1.5% N ON A DRY WEIGHT BASIS REQUIRED TO MAINTAIN VARIOUS CONSTANT YEARLY RATES OF N MINERALIZATION.

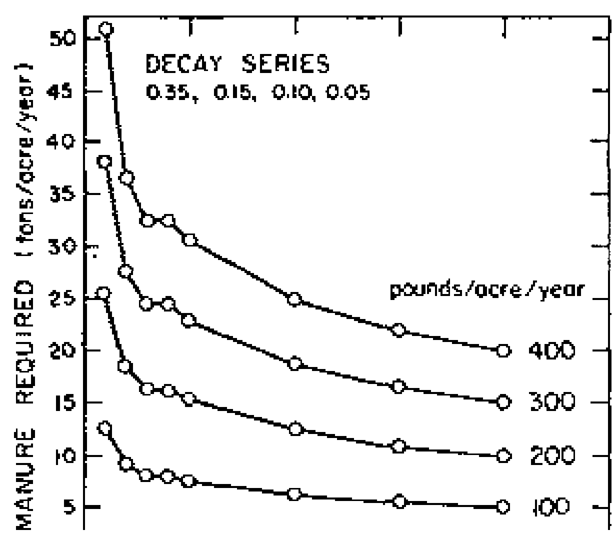


TABLE 1. RATIOS OF YEARLY MINERALIZATION RATES TO ANNUAL APPLICATION RATES OF ORGANIC WASTES AT CONSTANT ANNUAL INPUTS OF N FOR SIX DECAY SERIES FOR VARIOUS TIMES FOLLOWING THE INITIAL APPLICATION.*

Decay series	Typical material†	Time, years							
		1	2	3	4	5	10	15	20
		Mineralization/application ratio							
0.90, 0.10, 0.05	Chicken manure	0.90	0.91	0.92	0.92	0.92	0.94	0.95	0.96
0.75, 0.15, 0.10, 0.05	Fresh bovine waste, 3.5% N	0.75	0.79	0.81	0.82	0.83	0.87	0.90	0.92
0.40, 0.25, 0.06	Dry corral manure, 2.5% N	0.40	0.55	0.58	0.60	0.63	0.73	0.80	0.85
0.35, 0.15, 0.10, 0.05	Dry corral manure, 1.5% N	0.35	0.45	0.50	0.53	0.55	0.65	0.73	0.79
0.20, 0.10, 0.05	Dry corral manure, 1.0% N	0.20	0.28	0.33	0.35	0.38	0.52	0.63	0.72
0.35, 0.10, 0.05	Liquid sludge 2.5% N	0.35	0.42	0.44	0.47	0.50	0.61	0.70	0.77

* This ratio equals the pounds of mineralized N in any year per pound of N added per year.
† The N content is on a dry weight basis.

TABLE 2. RATIO OF YEARLY N INPUT TO ANNUAL N MINERALIZATION RATE OF ORGANIC WASTES AT CONSTANT YEARLY MINERALIZATION RATE FOR SIX DECAY SERIES FOR VARIOUS TIMES FOLLOWING INITIAL APPLICATION*

Decay series	Typical material†	Time, years							
		1	2	3	4	5	10	15	20
		N input/mineralization ratio							
0.90, 0.10, 0.05	Chicken manure	1.11	1.10	1.09	1.09	1.08	1.06	1.05	1.04
0.75, 0.15, 0.10, 0.05	Fresh bovine waste, 3.5% N	1.33	1.27	1.25	1.22	1.20	1.15	1.11	1.08
0.40, 0.25, 0.06	Dry corral manure, 2.5% N	2.50	1.56	1.74	1.58	1.54	1.29	1.16	1.09
0.35, 0.15, 0.10, 0.05	Dry corral manure, 1.5% N	2.86	2.06	1.43	1.82	1.72	1.40	1.25	1.12
0.20, 0.10, 0.05	Dry corral manure, 1.0% N	5.00	3.00	2.9	2.44	2.17	1.38	1.13	1.04
0.35, 0.10, 0.05	Liquid sludge, 2.5% N	2.86	2.33	2.19	2.03	1.90	1.45	1.23	1.11

* This ratio equals pounds of N input required to maintain a constant annual rate of N mineralization.
† The N content is on a dry weight basis.

TABLE 3. TOTAL N INPUT REQUIRED TO MAINTAIN A YEARLY MINERALIZATION RATE OF 200 POUNDS PER ACRE/YEAR THROUGH A 20-YEAR PERIOD FOR TWO DECAY SERIES FOR EACH OF SIX TYPES OF WASTES*

Material and decay series	Time, years							
	1	2	3	4	5	10	15	20
	Nitrogen input, lbs/acre/year							
Chicken manure								
0.90, 0.10, 0.075, 0.05, 0.04, 0.03	222	220	218	217	216	214	213	210
0.90, 0.10, 0.05	222	220	219	218	217	213	209	207
Fresh bovine waste, 3.5% N								
0.75, 0.15, 0.10, 0.075, 0.05, 0.04, 0.03	267	253	248	242	240	231	223	218
0.75, 0.15, 0.10, 0.05	267	253	246	244	241	230	221	215
Dry corral manure, 2.5% N								
0.40, 0.25, 0.06, 0.03	500	332	349	332	326	295	272	255
0.40, 0.25, 0.06	500	312	349	316	308	258	232	218
Dry corral manure, 1.5% N								
0.35, 0.15, 0.10, 0.075, 0.05, 0.04	571	412	367	343	336	291	270	240
0.35, 0.15, 0.10, 0.05	571	412	347	364	344	281	245	225
Dry corral manure, 1.0% N								
0.20, 0.10, 0.075, 0.05, 0.04, 0.03	1000	600	490	475	451	367	300	261
0.20, 0.10, 0.05	1000	600	540	489	437	277	225	208
Liquid sludge, 2.5% N								
0.35, 0.10, 0.06, 0.05, 0.04, 0.03	571	465	427	400	384	351	292	265
0.35, 0.10, 0.05	571	465	437	406	379	290	245	223

* The first decay series presented is meant to represent a slower rate of mineralization of the residual N from each yearly application.

is considered to be typical of organic materials in which the N is largely in the form of urea or uric acid which mineralize rapidly and easily. Such materials are nearly as available as inorganic sources. Chicken manure is considered to be nearly as available as inorganic sources and is thus listed as a typical example of this decay series. The series 0.75, 0.15, 0.10. 0.05 represents materials in which about 50% of the N is in the form of urea or uric acid; the other half consisting of N in the form of slowly mineralizable organic compounds. Fresh wastes from dairy cows or beef cattle are in this category.

The other four decay series are used to represent materials containing mostly slowly mineralizable organic N compounds, such as cattle or dairy manure that has accumulated and dried in corrals for various amounts of time, and digested municipal sludges. The specific decay series used here for sludge should not be considered appropriate for all municipal sludges. Some sludges have much lower N contents and thus have lower rates of decay.

Constant output approach

The "output" is the yearly mineralization of N. The objective of this approach is to determine the amounts of any given materials required per year to maintain given yearly rates of mineralization. Table 2 presents the ratio of yearly inputs to the annual N yearly mineralization rate, at a constant yearly mineralization rate for six decay series for a 20-year period. In this case the application rate for any specific year can be obtained by multiplying the ratio for that year times the yearly mineralization rate desired. For example, if a constant yearly mineralization rate of 100 lbs N per acre per year were desired, for a decay series of 0.40, 0.25, 0.06, the input rates would be 250, 156, 154 and 100 lbs per acre per year respectively for the first, second, fifth and twentieth years. Using these ratios the required amounts of any of the six materials can be calculated if the exact N and water contents are known.

Graph 2 presents the relationships among yearly rates of application, time and constant yearly rates of mineralization for manure containing 25% water and 1.5% N on a dry weight basis, and a decay series of 0.35, 0.15, 0.10, 0.05. To maintain a yearly output of 200 lbs of mineral N per acre per year, 25.5, 15.5, 12.5, 11 and 10 tons of manure per acre would be required for the first, fifth, tenth, fifteenth and twentieth years, respectively.

Table 3 presents data for the total N inputs required to maintain a yearly mineralization rate of 200 lbs N per acre per year for a 20-year period for two decay series for each of six types of wastes. The first decay series listed in each case is the more conservative in that the final member of the series is 0.03 or 0.04 —considered to be appropriate for colder climates where decay would be slower. With chicken manure and fresh bovine waste, the two decay series gave essentially the same data. With the other materials the differences between the series were 15 to 55 lbs per acre per year during the twentieth year. The comparison for the dry corral manure at 2.5% N is the best because the two series differ by only one number. In this case the differences in input rates are 18, 37, 40 and 37 lbs N per acre per year for the fifth, tenth, fifteenth and twentieth years, respectively. Considering variability in the material and the difficulty in getting uniform field distribution, these differences probably have no practical significance.

If inorganic sources of N were to be completely replaced by organic sources for a given cropping system, this constant output approach would be much more desirable than the constant input approach. However, the limitations of the constant output approach might be the soluble salts that are added with the high rates of organics required during the first few years. In some moderately saline soils, the increment of salt added with the manure might be sufficient to reduce yields during the first few years.

Discussion

The decay series used here are largely the results of the combined judgment of the authors—except the series 0.40, 0.25, 0.06 which was taken from a field trial in the Coachella Valley, in which the availability of the N added as manure was compared with the availability of inorganic sources. The selected values are based on the authors' experiences in studying the decomposition of a variety of organic materials including animal wastes.

The data presented here are based on decay series that have not been tested in the field. They should be tested in well designed long-term field trials, but until such trials are completed, these data might be useful in planning waste disposal projects and for the development of a more rational use of organics as N sources. The approach used here could be applied to other materials and to other climates that would result in decay series other than those used in this report.

P. F. Pratt and J. P. Martin are Professors, Department of Soil Science and Agricultural Engineering, University of California, Riverside; and F. E. Broadbent is Professor, Department of Soils and Plant Nutrition, U.C. Davis.

Techniques for Measuring Source and Yield of Sediment
Committee 4

The following charges were given to the committee:

1. Assess the various techniques that can be used to measure the yield from sources such as:

    a. Construction areas.
    b. Mining areas.
    c. Critical eroding areas or point source and from areas of active erosion.
    [redacted]

2. Recommend techniques best adaped for specific situations such as 1. a-d above.

3. Assess use of Soil Erodibility Nomograph developed by Wischmeier for developing Soil Erodibility Factor (K) in the Universal Soil Loss equation.

The charges to this committee stem from the long standing difference between specialists in the eastern and western states concerning use of the Universal Soil Loss equation. Much of this difference relates to the complexity of the physical-biological system and to the paucity of data, particularly in the western states. The need for basic data is immense considering demands for specific site hazard ratings or sediment yield predictions which are truly effective and capable of standing in a court of law.

Two approaches to the prediction of soil loss have received national attention and use. Musgrave 1/ reported on a large number of measurements of soil loss relating to specific storms in the U. S. He developed the relationship:

$$E = IRS^{1.35} L^{0.35} P_{30}^{1.75}$$

Where E = *soil loss in acre inches*, I = *inherent soil erodibility*, R = *cover factor*, S = *slope in* degrees, L = slope length in feet and P is the maximum 30-minute amount of rainfall in inches at a 2-year frequency. This equation was reported to be useful for long-term average soil loss over broad areas.

In 1961 and subsequently, the USDA ARS has offered a "universal soil loss equation" which used total rainfall energy rather than total precipitation (including snow). This equation is represented by:

$$A = R\ K\ L\ S\ C\ P$$

Where A = average soil loss in tons/acre, R = rainfall factor, K = soil erodibility factor, LS = slope length and steepness, C = cropping and management factor and P = supporting conservation practice.

Wischmeier and Smith 2/ refined factor R as:

$$R = \frac{\sum EI}{100}$$

Where E = storm energy in foot tons/acre inch and I = maximum 30-minute intensity in inches/hour.

Soil erodibility factor K describes the inherent soil erodibility expressed as tons/acre/unit of rainfall-erosion index (R). Continuous fallow tillage on a 9%, 73-foot long slope is assumed.

1/ Musgrave, G. W. The quantitative evaluation of factors in water erosion: a first approximation. J. Soil Water Conservation, Vol. 2, No. 3, pp 133-138, July 1947.

2/ Wischmeier, W. H. and D. D. Smith. Rainfall energy and its relationship to soil loss. Trans. Am. Geophysical Union, Vol. 39, No. 2, pp 285-291, April 1958.

A third method, currently used by Forest Service in some of the western states was developed by Anderson (1969, copy attached). This procedure, for forested lands of the Southwestern U. S., was adapted from Musgrave.

However, it provides a more realistic coefficient for slopes greater than 30%. It also provides for soil cover density (see p. 22-24) in terms of actual ground cover versus cover associated with a specific management intensity or crop use as developed by ARS. It considers both splash and overland flow energy relationships.

From this brief review, it appears there are several recommendations this committee can make which will help develop a system suitable for western lands and land uses.

1. Rainfall erosion index. This index currently is a function of storm energy and rainfall intensity. [redacted] soil erosion is needed. To assure utility of the results, hydrologists and soil scientists from the land management agencies, federal, state and private as well as SCS, ARS and universities should be involved in these efforts. Commitment to the results could possibly be improved by parceling out segments of the needed research work to research groups of the agencies listed above.

Recommendations:

1. The National Cooperative Soil Survey in conjunction with ARS should encourage and involve major federal, state and private land management agencies in research leading to more precision in the R factor for western conditions. The NCSS role would be one of coordination and assistance in selection of appropriate benchmark sites to assure maximum data extendibility.

2. Cropping, management and conservation practice (Universal factors C and P).

   The present nomographs, charts and tables are developed primarily from row crop agricultural areas of the east and midwest. These figures need to be expanded for a wide variety of land uses and vegetative cover types in both east to west. Broad class categories such as "rangeland," or "Douglas-fir forest land" are not satisfactory categories. Cover types, to have universal significance, should be related to overall ground protection, and to the radiation energy budget; a function of overstory, understory and litter. This cover factor should be a variable function depending on the sequence of climatic events, i.e., a full soil cover during periods of little potential runoff, versus minimal soil cover during periods of potential overland flow should be accounted for in these categories. The conservation practice factor also is in need of broadening to include forest and range conservation practices as related to multiple forest and rangeland uses, often occurring on the same acre of ground.

   The role of the ground cover and conservation practice factors in the Universal equation needs better definition. Again this work should involve not only ARS and SCS and universities but also the major federal, state and private land management agencies. Quite clearly, the major inputs to make this system universal, will be standards for the nonagricultural lands.

Recommendations:

The NCSS in conjunction with ARS should encourage and involve major federal, state and private land management agencies in establishing a more precise cover and conservation practice factor (system - universal factors C&P) for nonagricultural lands, nationwide. The NCSS role should be to coordinate and assist in selection of appropriate benchmark sites to assure maximum data extendibility.

In regard to Charge 1, a quick review of the literature does not disclose there is any adapted technique equally suitable for items a, b and c. In practice, there is commonly a progressive impact on a site or area as the disturbance activity continues. The first stage might be excavation and relocation of raw, freshly exposed materials, interference with vertical and lateral percolation, settling and shear effects. The second stage might involve the lag time before revegetation. The third stage may be represented as one of reestablishment of vegetative cover and a gradual flushing of sediment from aggraded channels. A fourth stage might be increased channel scour as a result of upstream stage 1 and 2 activities.

Techniques now available such as the universal equation have no factors universally suitable for relative sediment prediction from such disturbed sites. Most sediment predictions for such sites are based on projections of measurement on the same or similar sites. Ring-on-post, tight wire and sediment traps are 3 such techniques for evaluating soil loss. Generally the technique used is dependent upon factors such as type and precision of data, characteristics of the site, and agents of erosion. Prediction equations such as the Universal could possibly be adapted to such areas by new sets of data for the individual factors. However, factors such as shear, piping, wet versus dry excavation and wasting must also be considered.

Recommendation:

NCSS cooperators, ARS and federal, state and private land management agencies should cooperatively engage in research to develop a technique(s) for predicting sediment yield on a sequential basis from sites 1 a, b and c. Item 1d would be covered under Recommendations 1 and 2 above.

In regard to Charge 3, there are some studies underway at present on refining the soil erodibility factor (K). Wischmeier's nomograph was developed primarily from eastern and midwest erosion plot data and apparently works well in that environment. Suggested improvements are to clarify the role of coarse fragments (surface and subsurface), clay mineralogy (including amorphous materials), salts or high sodium soils, very low or (very) high (more than 4%) organic matter content and variations in organic matter character. This committee suggests consideration be given to current research by Dr. Huntington as this leads to recommendations for improvement of this factor. In passing, it is the chairman's experience that the BER factors contained in the attached report by D. Anderson have been tried on several National Forests in Montana, Washington, Oregon and California, as well as the Forests in the Southwest, and were found to give rather reliable estimates of long time, broad area sediment yields, but the same technique is less useful for slopes west of the Cascade Mountains.

Recommendation:

This committee withholds its recommendation on Charge 3 in deference to research being conducted by Dr. Huntington and others.

One additional point which has merit for consideration in future research is to clearly differentiate on-site soil loss from off-site sediment yield. It was not clear to the committee that this difference was adequately covered in the Charges. Three possible approaches to measuring sediment yield from problem areas are: (1) Measure or evaluate soil loss and estimate how much gets into streams, (2) measure sediment yield of streams and try to identify sources, and (3) concentrate on studying the sediment delivery system from eroding source to stream. This committee's discussion has concentrated on evaluation and prediction of soil losses rather than on techniques of measuring either soil loss or sediment yield. Any future discussion of sediment yield must recognize that the channel may be a site of soil loss as well as deposition. The sediment delivery system, the channel function, the agents of erosion (including wind and gravity through soil creep and freezing and thawing) are all essential factors in understanding the broader aspects of soil movement.

Appendix I. Wischmeier, W. H., Johnson, C. B., and Cross, B. V. 1971. A Soil Erodibility Nomograph for Farmland and Construction Sites. Journal Soil and Water Conservation 26(5): 189-193.

Appendix II. Anderson, D. A. 1969. Guidelines for Computing Quantified Soil Erosion Hazard and On- [redacted]

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Discussion

Without further discussion, conference participants voted to accept the committee's report and continue the work of Committee #4. Several members of the committee including the chairman and several conference participants suggest the title and Charge 1 be clarified directing that the word "measure" or "measuring" be changed to "predict" or "predicting" as appropriate.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY
San Diego, California - January 21-25, 1974
REPORT OF THE COMMITTEE ON WATER RELATIONS IN SOILS
COMMITTEE No. 5

I. Charges to the Committee

A. Review definitions and criteria related to soil-water in "Soil Taxonomy" and in the draft of the "Soil Survey Manual" for inconsistence and adequacy for classification and interpretations.

B. Develop criteria for using soil moisture regimes as soil series criteria.

II. Committee activities

Major committee effort has been devoted to reviewing definitions and criteria pertaining to soil-water in "Soil Taxonomy" and the "Draft Soil Survey Manual." In addition, the Committee Report on "Soil Moisture and Temperature in Relation to Soil Classification and Interpretations," National Technical Work Planning Conference of the Cooperative Soil Survey, 1971 was reviewed and provided a valuable source of information for suggestions and recommendations formulated by this Committee.

III. Review of definitions and criteria related to soil-water in "Soil Taxonomy" (Preliminary abridged Text, October 1973).

The "Soil Taxonomy" is presently in GPO awaiting publication. The review of the "Abridged Text" was made primarily to assure familiarization with pertinent criteria and definitions as a basis to assure compatibility and consistency with the "Draft Soil Survey Manual."

This review indicated some inconsistency in the use of terminology relative to water movement. Specific examples regarding this problem include the following:

<u>Chapter 3</u>

Duripan p. 38: "slowly permeable"
Fragipan p. 39: "slowly permeable"
p. 40: "slow permeability"
Albic p. 41: "relatively impervious"
Petrocalcic p. 42: "hydraulic conductivity is moderately slow to very slow."

<u>Chapter 5</u>

Vertisols p. 63: "very slowly permeable when moist"

<u>Chapter 8</u>

Alqualfs p. 77: "low hydraulic conductivity"
Albaqualfs p. 77: "slow or very slow hydraulic conductivity"
Natraqualfs p. 81: "very slowly permeable"
Ochraqualfs p. 82: "saturated hydraulic conductivity of the argillic horizon is slow or very slow"

<u>Chapter 17</u>

Vertisols p. 313: "hydraulic conductivity of the soils is slow or very slow"

The use of water movement terminology illustrated above indicated potential inaccuracies which may result in misunderstanding relative to intent, and errors in interpretations.

IV. Review of definitions and criteria related to soil-water in the "Draft Soil Survey Manual."

Major subject matter within the scope of responsibility of this Committee are contained in the following chapters of the "Draft Soil Survey Manual":

Chapter 4 - Characterizing Polypedons
Chapter 6 - Developing Soil Legends
Chapter 8 - Investigations in Support of Soil Surveys
Appendix 8 - Soil Drainage Classes

Definitions, criteria and discussion in regard to soil-water contained in the above chapters have an important application to properties and conventions set forth in Chapter 5 - Describing

Pedons. Therefore, consistency, particularly in regard to terminology and definitions should be [redacted]

of water held against specified soil moisture tensions. In order to avoid misunderstanding and clarify definitions it has been suggested that a definition of soil moisture tension be inserted on page 4-45 following the 1st paragraph.

The following insertion is recommended:

"The movement and retention of water in soil is concerned with the tenacity with which soil holds water. Moisture retention curves show the relationship between the amount of water held by soil and soil moisture tension. Pressure potential in soil-water systems has been explained by Hillel (1971) as follows: When soil-water is at a hydrostatic pressure greater than atmospheric, its pressure potential is considered positive. When it is at a pressure lower than atmospheric (a subpressure known as tension or suction), the pressure potential is considered negative. Thus, water under a free-water surface is at positive pressure potential, while water at such a surface is at zero pressure potential, and water which has risen in a capillary tube above that surface is characterized by a negative pressure potential." (Hillel, Daniel. Soil and Water--Physical Principles and Processes. Academic Press, 1971).

2. P. 4-46, Paragraph-1, Sentence-1 - Revise to read: "Oven-dry refers to soil material dried at 105° to 110° C, a state that -----." (Report of Definitions Approved by the Committee on Terminology, SSSA 1955).

3. P. 4-46, Paragraph 3, (Moist soil) - The range in moisture content for moist soil as defined in the "Draft Manual" is a water retention < 15 bar moisture and > 0.1 bar moisture. This conflicts somewhat with the definition of the moist soil moisture regime as defined in "Soil Taxonomy" which states: "If water is held at a tension of < 15 bars but more than zero, we consider the horizon to be moist."

Although the reference in the one instance is to "soil moisture regime" and the other to [redacted]

contains water removed by a tension of 0.1 bar."

5. P. 4-47, Paragraph-2, Sentence-2 (Wet soil) - Revise to read: "If the moisture is under tension, gravity would not remove water from the pores if the soil were free to drain."

6. P. 4-47, Paragraph-2, Sentence-5 which ends on P. 4-48 (Wet soil) - Revise to read: "Water under zero tension or positive pressure is called free water for convenience in this Manual--free to move under the force of gravity."

7. P. 4-47 - P. 4-48 (Wet soil) - The range in moisture content for wet soil is included in that specified for the moist soil moisture regime as defined in "Soil Taxonomy." In this instance also there may be some confusion in the application of the terms.

8. P. 4-49, Paragraph-3, Sentence-3 - The reference sentence indicates that use of the term [redacted]

9. Pp. 4-50 - 4-55, How Water Moves in the Soil

a. This section of Chapter 4 indicates major revision in the present Manual which involves substitution of relative classes and subclasses of "perviousness" for classes of "permeability." Three primary classes of perviousness with subclasses are provided as follows:

Class 1 - Slowly pervious
Subclass - very slowly pervious

Class 2 - Moderately pervious
Subclass - Moderately slowly pervious
Subclass - Moderately rapidly pervious

Class 3 - Rapidly pervious
Subclass - Somewhat rapidly pervious
Subclass - Very rapidly pervious

The class and subclass definitions are based on relative potential to transmit water vertically and include strong inferences in regard to suitability for disposal of septic tank effluent in absorption fields. Reasoning set forth for the revision is as follows (pp. 4-50 - 4-51).:

> The concept of water transmission within the soil under the influence of gravity with associated capillary phenomena are summarized here under the term perviousness.
>
> Perviousness corresponds generally to the term "permeability" used in the 1951 edition of this Manual. Permeability, too, refers to the property of a porous medium that permits it to transmit water (or air) (Soil Sci. Soc. Amer., 1965). It is used by soil physicists and others, however, to identify quantitative values that are precisely defined terms of dimensions and that imply certain kinds of operations for determination. To avoid the inevitable misunderstanding when a term is used in somewhat different ways, the term perviousness has been substituted for those qualitative judgments of water-transmitting potential made by soil surveys. The term "pervious" means, literally, "can be penetrated or permeated--or allows passage through." (Gove, 1969).

b. The Committee believes that substitution of "perviousness" for "permeability" will not resolve criticism inherent in the latter property as presently used in soil survey. In addition classes of perviousness lack quantitative limits which are needed to make field estimates, and to coordinate and correlate field data with laboratory and research support. These major deficiencies in the "classes of perviousnes" will not provide essential data needed for a broad scope of interpretations which we believe is inherent in the present and future competence of the soil survey.

c. The Report of the Committee on Soil Moisture and Temperature in Relation to Soil Classification and Interpretation, NTWPC for Soil Survey (Jan. 1971) presented a comprehensive discussion of soil-water in its report and attached appendix which was prepared to explore the subject preliminary to revision of the Soil Survey Manual.

The 1971 National Committee report indicated that if the reasoning contained in the appendix were followed that significant changes from the present Manual and current field practices would be required. Also in regard to water movement the following was indicated in the discussion:

> The emphasis in water movement would be on saturated hydraulic conductivity but classes of unsaturated hydraulic conductivity would be provided. In present practice, the horizon of minimum hydraulic conductivity (if not at the surface) determines the placement of the soil. This emphasizes the vertical saturated hydraulic conductivity to the exclusion of the horizontal. The option of placement based on the minimum horizon would be permitted, but also more complete placements would be encouraged. Hopefully, the latter would have some relevance to lateral water movement and to infiltration. There are few data on unsaturated hydraulic conductivity. We have scant basis on which to define classes. Help is needed from specialists in the subject. Saturated hydraulic conductivity is largely controlled by the continuity of voids larger than about 0.1 mm. Unsaturated hydraulic conductivity if for a low tension, such as the 30 millibars suggested in the appendix, decreases as the volume proportion of voids larger than 0.1 mm increases. The description of macroscopic voids in the revised Manual should be coordinated with the approach taken to hydraulic conductivity.

In its recommendations the 1971 National Committee included under Recommendation No. 5:

> Classes of saturated hydraulic conductivity in the revised Manual should permit

placements that are indicative of the horizontal as well as vertical movement. Advice should be obtained from soil physicists in the Agricultural Research Service or at the Universities on the establishment of classes of unsaturated hydraulic conductivity.

d. In planning revisions concerning water movement in the present "Draft Soil Survey [illegible]

The appendix to the 1971 National Committee report suggested the following classes for saturated conductivity.

cm/day	ins/hr*	ins/day*	Class name**
< 10	< 0.16	< 3.9	low
< 1	< 0.016	< 0.39	very low
1-10	0.016-0.16	0.39-3.9	low
10-100	0.16-1.6	3.9-39	moderately low
> 100	> 1.6	> 39	high
100-1000	1.6-16	39-394	moderately high
> 1000	> 16	> 394	very high

*Conversion made by 1974 Western Committee
**Suggested class names by 1974 Western Committee

An alternative to the suggested national classes would be one to equate present permeability classes and numerical limits to classes of saturated hydraulic conductivity:

Permeability class	ins/hr	cm/day	Class of saturated hydraulic conductivity
very slow	< 0.06	3.8	very low
slow	0.06-0.20	3.8- 12.5	low
moderately slow	0.20-0.63	12.5- 38.4	moderately low
moderate	0.63-2.0	38.4-121.9	moderate
moderately rapid	2.0 -6.3	121.9-384	moderately high
rapid	6.3 -20	384 -1200	high
very rapid	> 20	> 1200	very high

In regard to unsaturated hydraulic conductivity the Committee agrees with the 1971 opinion of the National Committee which indicated that little data and experience is available for establishing class limits. In addition because of the relationship of unsaturated hydraulic conductivity to soil moisture tension it is uncertain if such classes should be established. We believe however, that criteria and guidelines for use in making qualitative inferences and interpretations should at this time be developed and included in the revised Manual.

e. Conventions for application of classes of saturated hydraulic conductivity to soil horizons and soils (pp. 4-51 and 4-55) should remain essentially as written except for substitution of terminology. The last sentence, Paragraph-2, p. 4-55 which states "Mixing by deep plowing is required if such soils are to be irrigated successfully," should be deleted.

10. Pp. 4-57 - 4-65, Sequences of Soil-Water States

a. This section establishes and defines 22 classes and subclasses of sequences of soil moisture states which are to be used to characterize normal patterns of change in soil moisture states with time. The various classes and subclasses defined indicate no inconsistency with the eight classes of soil moisture regimes defined in "Soil Taxonomy."

b. P. 4-58, Paragraph-1, Sentence-1 - Revise to read: "Soil Taxonomy" defines eight classes of soil moisture regimes."

c. P. 4-65: The titles for each group (A, B, C, D, E) should indicate "Sequences of Soil-Water States that are-----." Group B should be indicated as Udic-soil moisture regime; group C as Ustic and group D as Xeric.

d. The Committee also suggests that in order to avoid the possibility that sequences of soil-water states might be used in place of precise definitions for soil moisture regimes that the following be added as a last sentence to paragraph-1, p. 4-58: "Definitions of the patterns of soil-water states which follow are not sufficiently detailed for most classification and research purposes, but may be used where there is a need for making interpretations of soil maps for the general public."

B. Review of Chapter 6 - Developing Soil Legends (p. 6-57), Phases Related to Soil-Water

1. Since drainage classes are included only in Appendix 8 for purposes of historical reference and interpretations, they should be eliminated as Drainage Class Phases (p. 6-57). Wetness phases, water table phases, and drained phases should cover all needs. Drainage Class Phases have not been used in any recent final correlations in the Western Region.

2. Definitions, criteria and conventions should be developed for use of various water table, wetness, and drained phases.

C. Review of Chapter 8 - Investigations in Support of Soil Surveys, (pp. 8-24 - 8-33).

1. P. 8-24, Soil-Water, Paragraph-1 - Insert the following at the end of the first sentence: "In the soil there are force fields acting on water. Those with the greatest influence include the force of gravity (gravity potential), adsorption between solid surfaces and cohesive forces between water molecules (matric potential), and the attraction between ions and water molecules (osmotic potential). The soil-water potential is negative in sign since work is required to remove an increment of water from an unsaturated soil."

2. P. 8-24 - 8-25, Soil-Water, Paragraph-2 - Revise sentence 3 to read: "At low water potential, i.e., 15 bar, the quantity of water held depends on surface area (texture) and at high water potential, i.e., 1/10 or 1/3 bar, on the geometry of soil pores."

3. Pp. 8-25, 8-27, 8-29, and 8-30: The sign (-) for indicated water potential and moisture tension is shown. The sign (-) is not included for the indicated tension value at the bottom of p. 8-32. The sign (-) also has not been included for values of soil moisture tension in other chapters of the "Draft Manual." This represents an inconsistency which should be explained or reconciled.

4. P. 8-28, Amount of Water in Soils, Laboratory Measurements - Revise Sentence-1 to read: "A soil sample is dried at 105°-110° C until it reaches constant weight." (Report of Approved Terminology, SSSA, 1955). Second sentence: The equation for "Pct. water" requires "x 100."

5. P. 8-29, Soil-Water Potential, Laboratory Measurements, Paragraph-1, Sentence-1 - Insert "(saturation)" following "zero water potential." The revised sentence to read: "Water retentivity near zero water potential (saturation) depends primarily upon the size of the pores.

D. Review of Appendix 8 - Soil Drainage Classes.

This Appendix reproduces the seven soil drainage classes described in the 1951 Manual. It is suggested that the terminology used be checked for consistency with that listed and defined in the final draft of the revised Manual.

V. Criteria for using soil moisture regimes as soil series differentiae.

The charge given the Committee directed devlopment for use of soil moisture regimes to differentiate soil series. We have assumed that the intent was for using classes of soil moisture regimes. The Committee has given only minor attention to this charge due to time consuming emphasis given to the first assignment.

A. Moisture regimes are used in definitions of taxa at high levels of the "Soil Taxonomy." Soil families and soil series consequently carry this differentia. The general concensus of the Committee is that moisture regimes be used as series differentiae only if the difference can be substantiated in the setting and it has a valid use for interpretations. This would [redacted]

B. [redacted]

1. Aquic subgroups of Torriorthents, Udorthents, Ustorthents, Xerorthents are saturated with water within 1.5 m (60 inches). Soil series may be differentiated within families of aquic subgroups by depth to saturated layers within the 1.5 m profile.

A similar differentiation could be made for soil series in other aquic subgroups of Aridisols and in a number of other soil orders.

[redacted]

A. The Conference membership approve Committee recommendations and suggestions for revisions in pertinent parts of Chapters 4, 6, and 8, and Appendix 8 in the "Draft Soil Survey Manual."

B. Criteria and definitions for soil-water states and water movement in the revised Manual be closely coordinated with criteria, guides, and conventions for describing pedons (Chapter 5). [redacted]

C. The development of criteria for use of soil moisture regimes as soil series differentiae needs to be further studied. The concensus of some members of this Committee is that the criteria for "Soil Taxonomy" subgroups are sufficient. In any event it appears that any consideration of criteria should have its basis in effects on plant growth and yield, and field tested for validity.

D. Terminology relative to soil-water, particularly water movement which are used in "Soil Taxonomy" should be reconciled in future revisions of this publication with that of the final version of the revised Soil Survey Manual.

E. The Committee should be continued.

The report of the Committee was approved and accepted by the Conference membership.

Committee Members

E. A. Naphan, Chairman	R. D. Hall
F. T. Miller	H. Ikawa
T. J. Holder	W. A. Starr
J. E. Brown	W. D. Nettleton
R. Mitchell	C. A. Lowitz
E. M. Richlen	

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Classification of Soils That Have Bee" Altered by Mining Operations and Interpretations

Committee 6 was assigned two charges dealing with land altered by mining operations.

CHARGE 1: Develop procedure for classifying soils altered by surface mining operations at several levels in the taxonomic system.

The Committee was in "early unanimous agreement that soils altered by surface mining operations should all be classified in the Order of Entisols. The next level of classification, it was agreed, should be the Suborder Orthents. The lowest level of classification, except for phases, should be one of the following Great Groups: Cryorthents, Ustorthents, Torriorthents, Udorthents, or Xerorthents.

The Committee agreed, prior to the Regional Conference, that each Great Group should be placed in the appropriate Family level of the Taxonomy. However, at the conference it was pointed out that any soil classified to the Family level must have identification as a Series. This, of course, is impossible. As a" alternative it was suggested by a conference member that the Great Groups could be phased using Family level terminology. For example: Loamy, nonacid Ustorthents, or Clayey, acid Udorthenta. The Family level terminology would apply to a 25- to 100-centimeter control section. The Committee agreed that textural modifiers most reasonably only include the following: sandy, sandy-skeletal, loamy, loamy-skeletal, clayey, clayey-skeletal, and fragmental.

The Committee agreed that classification of soils altered by mining operations should be kept simple and yet meaningful. The committee as well as the majority of the conference members believe the above proposal achieves this end.

The question concerning the naming of mapping units was raised by the Committee and at the conference. The majority agreed that users of soil surveys ought to **know from the name the soils that have been0 0 1 125.2e 0ÃÇ áþƒ1 39273 72.001 -10r**

CHARGE 2: Develop criteria for interpreting soils altered by mining for various uses.

The Committee agreed that soils altered by mining operations, when described as they should be, can be interpreted using guides already available. Conference members also fully agreed with this.

Ted Miller (SCS State Soil Scientist) expressed concern about providing information in regard to identifying quality of soil materials that might be used in mining reclamation. The SCS in North Dakota developed a guide to help do this. This guide is being presented as a part of this report. The conference membership favored using the criteria for rating soils as a source of topsoil instead of adopting a new guide.

The report of the committee was approved and accepted by the conference membership.

<u>Committee Members</u>:

J. W. Rogers, Chairman *
R. C. Kronenberger *
F. T. Miller
D. L. Bannister
Hollice Omodt
Fred Westin
Vern Hugie
P. c. Singleton

* Members present at San Diego.

SOIL INTERPRETATIONS FOR STRIP MINED LAND

Basic soils information is essential in obtaining satisfactory reclamation and restoration of lands disturbed by surface mines. Soil interpretations used in conjunction with the soil maps can indicate to planners, engineers and others the advisability of selecting, stockpiling and using specific soils as final cover for mined land.

Soil characteristics and interpretations significant to their use as final cover for mined land are given in the attached table. Soil characteristics or properties are estimated for representative soil profiles. These estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other areas. The interpretations are based on the soil properties and on the experience of soil scientists, agronomists and engineers with these soils. Following are explanations of some of the columns.

Parent Material: The disintegrated and partly weathered rock from which soil was formed.

Natural Soil Drainage: Drainage that existed during the development of the soil as opposed to altered drainage or irrigation. Soil drainage as a condition of the soil refers to the frequency end duration of periods when the soil is free of Saturation or partial saturation. Such conditions can be accurately measured, although the field scientist estimates them by inference. For class definitions, see Soil Survey Manual, pp. 169 to 172.

Depth of Rooting Zone: The depth of soil material that plant roots can penetrate readily to obtain water and plant nutrients. It is the depth to a layer that differs sufficiently from the overlying material in physical or chemical properties to prevent or seriously retard the growth of roots.

Available Water Capacity: The ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crops. The classes in the table are for a 60-inch soil profile and are as follows: Very low - 0 to 3 inches; Low - 3 to 6 inches; Moderate - 6 to 9 inches; High - 9 to 12 inches; Very high - more than 12 inches.

Permeability: That quality of a soil that enables it to transmit water or air. It is estimated on the basis of the soil characteristics observed in the field. particularly structure and porosity, and on the results of permeability and infiltration tests on undisturbed cores of similar soil material. The estimates do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Erodibility: Susceptibility to erosion, Estimates baaed on the following criteria:

Low - All soils in subclass IIe, level soils not subject to wind erosion, soils in class V and soils in 8 or w subclasses with erosion hazard comparable to that of subclass IIe soils.

Medium - All soils in subclass IIIe and soils in w or s subclasses with an erosion hazard comparable to that of subclass IIIe soils.

High - All soils except those that are coarse textured (Ifs, ls, etc.) in subclass IVe and soils in s subclasses with a comparable erosion hazard.

Very High - All soils in VIe, VIIe, coarse textured soils in IVe, and soils in s subclasses with a comparable erosion hazard.

Where wind erosion is a hazard, it is specifically mentioned, e.g., severe wind erosion.

Inherent Fertility: Natural fertility of the soil based on the following criteria:

Low - Soils low in available P or K, or with pH below 5.0 in the A and upper B horizons, or soils having levels of salinity or alkalinity such that choice of plants or growth of plants is severely limited.

Medium - Soils intermediate between low and high in inherent fertility.

High - Soils high in available P and K, with pH of 5.5 or more in A and upper B horizons; levels of salinity or alkalinity are sufficiently low that choices or growth of plants are not limited.

Where salinity or alkalinity is a limitation, it is mentioned in this column.

Estimated Yields: Estimated yields under high level of management for commonly grown dryland crops. These estimates are based on information obtained from farmers and other agricultural workers in the area. They are averages for a period long enough to include years of both favorable and unfavorable temperatures and moisture supply during the growing season.

Degree of Limitation for and Soil Features Affecting Final Cover for Mined Land: The ratings in these columns indicate the thickness and general suitability of soil materials that miaht be used as final cover for areas of mined land. The total thickness available, in inches, including that from A, B or C horizons is given in the first column. Relative suitability is shown in the second column. Only material that can serve as medium for plant growth is indicated end it is assumed that this material will be stockpiled and spread over leveled mine spoil.

Soil material given the rating good has physical, chemical and biological characteristics favorable for growth of vegetation. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments are characteristics that also affect suitability. In the following table, each of these characteristics is rated es to degree of limitation effecting use. The soil property giving the highest degree of limitation is used to rate the soil material as good, fair or poor.

Suitability Ratings of Soil Material for Use as Final Cover for Areas of Mined Land

Items Affecting Use	Degree of Soil Suitability: Good	Fair	Poor
Moist consistence	Very friable, friable	Loose, firm	Very firm, extremely firm
Texture	fsl, vfsl, 1, sil, sl	cl, scl, sicl	s, lfs, ls, c, sic
Coarse fragments: percent, by volume	Less than 3%	3 to 15%	More than 15%
Sodium content	Not class determining if less than 15% exchangeable sodium		More than 15% exchangeable sodium is unsuitable
Soluble salts: conductivity of saturation extract	Less than 4 mmhos/cm	4 t" 8 mmhos/cm	More than 8 mmhos/cm
Stoniness class 1/	0	1	2. 3, 4, & 5
Inherent fertility	High and medium	Medium	Low
Lime content	Low	Medium	High

1/ For class definitions, see <u>Soil Survey Manual</u>, pp. 216 to 223.

SOIL CHARACTERISTICS AND INTERPRETATIONS

Map Symbol	Soil Name	Land Cap. Sub-Class	Parent Material	Natural Soil Drainage Class 1/	Depth of Rooting Zone	Available Water Capacity	Permeability (Least perm. layer)	Erodibility	Inherent Fertility	Est. Yields (high management) Crops (dryland): Spring wheat bu/ac	Est. Yields: Barley bu/ac	Est. Yields: Oats bu/ac	Native Grazable Resources pdf/ac.	Degree of Limitation for and Soil Features Affecting Final Cover for Mined Land: Depth	Degree of Limitation for and Soil Features Affecting Final Cover for Mined Land: Suitability
32A	Parshall fine sandy loam, 0 to 3% slopes	IIIe	Fine sandy loam alluvium	Well drained!	60"	Mod	Mod. rapid	Medium	Medium	22	37	44	2150	o-37 37-60	Good Fair--medium lime
36B	Lihen loamy fine sand, 3 to 6% slopes	IVe	Sandy	Well drained	60"	Low	Rapid	Very high--severe wind erosion	Low	12	20	24	2200	60	Poor--sandy and mod. lime

1/ For class definitions, see Soil Survey Manual, pp. 169-172.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

REPORT OF COMMITTEE 7 - SOIL TAXONOMY

The committee comments on the three charges are summarized as follows:

Charge 1. Assess adequacy of soil moisture regime definition and use in the Soil Taxonomy.

Consensus of the committee is that moisture

Charge 2.

2. Requests for consideration of changes or clarification of criteria concerning several subgroups are as follows:

a. Boric great groups In Histosols. It is my understanding that Boro great groups were introduced Into the classification of Histosols In order to identify at a high taxonomic level those northern organic soils that have some potential for agriculture. The idea Is sound and I have no quarrel with it, but the present criteria for making the reparation are. in my opinion. illogical and at variance with the rest of the classification system.

Boric great groups are, in effect, defined by using a different definition of the cryic temperature regime for organic soils than for mineral soils (Soil Taxonomy, Abrldged Text, p. 54). The intent, apparently. is to use deep freezing in winter to identify soils that are warm in the summer and are therefore suitable for agricultural development. This may work well in strongly continental climates at the latitude of Michigan and Minnesota, but It creates problems in areas like Alaska. Histosols here occur under climates ranging from cool perhumid (where rolls seldom freeze under a thick winter snow cover) to pergelic (where they are always frozen except for a thin surface layer). The current definitions assign our warmest and coldest organic rolls to cryic great groups, and the soils in the middle Of the range (which freeze deeply in winter. but which thaw completely by the end of the summer) to boric great groups. That is, these organic soils of intermediate areas are both too warm and too cold to be cryic. It should be noted that all of the associated mineral soils are cryic throughout this entire range. and that there is very little chance that the Alaska Histosols distinguished by the "boric" designation can ever be used for crops.

I propose that we drop the special definition of the cryic temperature regime for organic rolls, and use the present mineral soil definition for all soils. Since most organic soils Other than Folists are saturated at some time during the summer and can be considered to have a histic epipedon, those with mean annual temperatures lower than 8 C and mean summer temperatures greater than $6^{o}C$ would have frigid temperature regimes. Boro great groups could be defined to include such soils If it is deemed necessary to separate them at the great group rather than the family level. If potentially arable Histosols are still included in cryic great groups, and there Is a need to separate them, intergrades to the boric great groups could be devised using appropriate summer temperature criteria.

(The above proposal was submitted to the National Task Force on Organic Soils last year, and war approved by that group.)

b. Definition of Sphagnofibrists. The present requirement for Sphagnofibrists Is that at least 3/4 of the-'fibers (by volume) in the upper 90 cm be derived from Sphagnum species. My observations indicate that many, if not most, of the soils we would ordinarily consider to be Sphagnum peats contain more than 25% sedge fibers below the surface tier. I believe it would be desirable to require only 1/2 Sphagnum fibers in the upper 120 cm (surface plus middle tier). provided that the upper 60 cm is 3/4 Sphagnum. The purpose is to group together all soils that are dominantly sphagnic. It is undoubtedly desirable to identify soils with relatively pure Sphagnum peat to great depth, but it seems to me that this could be done most appropriately at the series level.

c. Definitions of Typic and Dystric Cryandepts. As presently defined there are two distinct kinds of Typic Cryandepts--t ore that are dominantly nonthixotropic in the control section whether or not all of the material below 35 cm is of volcanic origin, and those that are dominantly thixotropic in the portion of the profile developed in volcanic ash but that have a nonvolcanic (and nonthixotropic) substratum that occupies more than one-half of the control section. The properties of these relatively shallow thixotropic Cryandepts that are of Importance in interpretations are more like those of the deeper thixotropic Cryandepts than of the nonthixotropic Cryandepts, and definitions should be written so that they can be grouped with

g. Concern regarding Vertisols vs. Vertic Subgroups in Frigid and Cryic Temperature Regimes. Some soil scientists in the field mentioned several problems with Vertisols and family textural classifications. The present classification system does not allow Vertisols to occur In frigid temperature regimes. It restricts the classification of these soils to mesic temperatures or warmer (chapter 17. Soil Taxonomy). These kinds of soils occur in many areas in the Western States that have frigid temperature regimes. At present these soils are classified into vertic subgroups. The taxonomy admits that soil moisture is necessary Lo the genesis of Vertisols, but nowhere does it specify the necessity of warm temperatures. Temperatures should have nothing to do with the shrinking and swelling action of these kinds of soils. It would seem that the criteria should be written to include any temperature regime, except of course pergelic, for the Proper classification of Vertisols.

Lithic Vertisols are about in the same category simply because cracking has to extend below 20 inches. Though these soils act as Vertisols, the total activity is not as great as those soils with depths greater than 20 inches. Perhaps a new category is needed to cover the shallow Vertisols when they occur over bedrock or duripans.

h. Problems with criteria related to Cryic Soils. It appears that a discussion is in order on the application of "O" horizon requirements as pertains to placement in cryic temperature regimes. Is there a stated of implied required thickness of the "O" horizon in this connection.

i. Mesic vs. Isomesic Temperature Regimes. A proposal is made to increase the difference between mean summer and mean winter soil temperatures from 5°C to 7 °C to affect more realistic grouping of soils with significantly different lengths of growing season which materially effects the choice of crops.

j. Request for clarification on Texture Family criteria as pertains to application to "thin solum" soils and soils with contrasting substrata.

Comments and questions as follows:

A Plus Bt horizons not extending to depths below 10 inches (chapter 18. page 4, item e at bottom of page). The present criteria requires, roils having argillic horizons not extending below 10 inches, that the textural family classification be considered from the upper boundary of the argillic horizon to 40 Inches or to restrictive lithlc paralithic, duripan, etc., whichever is shallower. This system works fine for these kinds of soils with contrasting textures between the argillic and underlying horizons. but what happens when no textural contrast exists, that is. a textural contrast not yet recognized. The family name the" does not consider the argillic horizon alone but groups it with the underlying horizons. Example: Consider a soil having a clay loam (fine loamy) argillic horizon with its lower boundary extending to depths of 6 to 9 inches. This argillic overlies sandy loam, loam, or silt loam (coarse loamy or coarse silty) horizons. The textural family classification would be fine loamy for the soil when considering the argillic horizon alone but would be a coarse loamy, coarse silty, or fine silty textural family when the underlying horizons are included. For reconnaissance soil surveys. this alone could cause one to Interpret these soils differently, i.e.. permeability. available water-holding capacity, etc. It has been argued that if there soils were plowed the argillic horizon would be lost due to mixing. Of course, many of these soils will never be plowed. Also, some soil scientists have gone so far as to classify these soils as Entisols because of the present criteria. This doer not aid in the proper mapping or classification of these soils. Perhaps thls criteria was developed with the thought of classifying roils to the soil series level of classification identification, and (It this level the criteria works very well. Phase names, such as th," solum phase. clay subsoil phase, etc.. are Presently being used; however. it would seem that additional criteria in the taxonomy would be a better way to handle these soils.

Charge 3. Assess adequacy of present distribution notices of classification update.

Several members of the committee agreed that present distribution was adequate. Several others expressed varying degrees of dissatisfaction. Some problems encountered Include:

1. Irregularity of notices.

2. Lack of sufficient copter to make necessary distribution.

3. Time required to manually up-date Vol. II if this Is attempted.

4. Serious concern that all holders of copies of Vol. II receive no notification Of changes.

5. Question on the part of several committee members as ta what means are being considered for notification of changes in both Volumes I and II once they are published and general distribution made.

While not related specifically to distribution Of change notices, some We concerned that all who could be affected have not had an opportunitv to review proposed chanqes of classification.

Recommendation: The committee should be continued.

Committee Members:
T. J. Holder, Chairman
A. R. Southard
G. Huntington
K. Larson
S. Rieger
G. M. Kennedy
R. F. Mitchel
L. D. Giese
D. M. Hendricks
A. 0. Ness

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

San Diego, California - Jan. 21-25, 1974

Report of Committee 8 - Improving Soil Survey Interpretations

Charges to the committee:

(1) Assess criteria for interpretations. Recommend needed amendments.

(2) Prepare guidelines for presenting information on overcoming soil limitations.

(3) Soil interpretations at the higher categories of soil taxonomy.

Response to the charges:

Charge 1 - The committee concentrated on assessing the criteria in the Guide for Interpreting Engineering Uses of Soils. Proposals for amendments to the Guide are summarized in Attachment 1.

Recommendations:

The Guide for Interpreting Engineering Uses of Soils should be revised and the proposals in Attachment 1 considered in the revision.

Emphasis in revising the Guide should be on improving the criteria and coordinating the sequence of items and the terminology with Form SCS-SOILS 5.

At least one representative from the western region should participate in the revision.

[redacted]

Recommendations:

[redacted]

Charge 3 - This topic was covered in considerable detail in the 1970 and 1972 reports of the National Conference and the 1971 and 1973 reports of the Western Conference. The Committee had nothing substantial to add.
(The committee report was accepted by the conference participants, along with the recommendation that the committee be continued.)

Committee Members:

J. M. Allen
D. V. Chenoweth
T. Collins
M. A. Fosberg
J. Hagihara
T. B. Hutchings
R. W. Kover
L. N. Langan
R. F. Mitchel, Chairman
T. Priest
W. E. Wildman

Attachment 1

CONTENTS

Attachment 1

PROPOSALS FOR AMENDMENTS - GUIDE FOR INTERPRETING ENGINEERING USES OF SOILS

DRAFT - SUBJECT TO REVIEW

Guide Sheet 5. -- Soil Limitation Ratings for Shallow Excavations

Item Affecting Use	Degree of Soil Limitation		
	Slight	Moderate	Severe
Seasonal water table 1/	Below a depth of 72 in.	Between depths of 40 and 72	Above a depth of 40 in.
Flooding	None or rare	Occasional	Frequent
Slope	o-15 pct.	15-25 pct.	More than 25 pct.
Texture of soil to depth to be excavated 2/, 3/	fsl, sl, 1, sil, sicl, scl, si, cl, and all gravelly and cobbly modifiers of above textures.	c, sic, sc, s, and ls with good sidewall stability and very gravelly and very cobbly modifiers with good wall stability.	organic soils; all s and ls, very gravelly and very cobbly modifiers with poor sidewall stability.
stoniness (Vol.)	Less than 15 pct.	15-35 pct.	More than 35 pct.
Depth to bedrock 4/ or hardpan	More than 60 in.	40-60 in.	Less than 40 in.
Bouldery class 5/	0	1, 2	3, 4, and 5

1/ Soils with measurable hydrodynamic pressures above a depth of 6 feet will be rated severe.

2/ Texture is used here as an index to workability and sidewall stability.

3/ If soil contains a fragipan, difficult to excavate with light equipment, increase the limitation rating by one step unless it is severe.

4/ If bedrock is soft enough, or the thickness or degree of cementation of the hardpan is such that it can be dug out with light equipment, reduce ratings of moderate and severe by one step.

5/ For class definitions see Soil Survey Manual, pp. 216-223.

Column 5. -- Dwellings. In this column give ratings for undisturbed soils on which single-family dwelling or other structures with similar foundation requirements can be built. Buildings of more than than three stories and other buildings requiring a foundation load in excess of that of a three-story dwelling are not considered in the entries in this column.

The emphasis in rating soils for dwellings is on the properties that affect foundations, but also considered beyond the effects related exclusively to foundations are slope, susceptibility to flooding, seasonal wetness, and other hydrologic conditions. The properties influencing foundation support are those affecting bearing capacity and settlement under load. Properties affecting bearing strength and settlement of the natural soil are density, wetness, flooding, plasticity, texture, and shrink-swell. Also considered are soil properties, particularly depth to bedrock, that influence site preparation.

Frost action potential of the soil is an important soil property that can influence the bearing capacity and settlement under load. This property, however, can have variable effects upon dwellings depending upon the amount of site preparation, depth of footings, texture, amount of water available for freezing, and soil temperature. Each of these factors can be evaluated for a soil prior to the construction of the dwelling. Once constructed, the amount of water available from roof drip can increase and soil temperature can increase thus altering the frost-action potential from its norm. This interpretation is given separately in the table of estimated soil properties. It is important to note that interpretations of soil properties affecting the ease and cost of foundation excavation and excavations that influence installation of utilities, such as water lines, are not considered in this interpretation. These interpretations are given separately as soil limitation ratings for shallow excavations. It is important, however, to note that on-site investigations are needed for interpretations relevant to detailed design of foundations and to specific placement of buildings and utility lines.

It also is important to note that interpretations for soil-induced corrosivity of steel and concrete are not included in these ratings. Those interpretations are given separately in the table of estimated soil properties. Also, interpretations for use of soils as septic tank absorption fields are not included in the ratings for dwellings; those interpretations are given separately.

Rating soils for dwellings must be made on an individual basis depending upon the type of construction: with basements, without basements, and concrete slad. Each type of construction has specific design needs that require individual assumptions.

1. Dwellings without basements: it is assumed these structures will be constructed with conventional spread footings placed at a depth of 2 feet. It is further assumed that lateral pressures resulting from expansive (shrink-swell) materials will not adversely affect the footings or vertical wall. Vertical pressures resulting from expansive (shirnk-swell) materials below the footings, however, must be considered.

2. Dwellings with basements: It is assumed these structure will be constructed with conventional spread footings placed at a depth of 5 feet. It is also assumed that lateral pressures resulting from expansive (shrink-swell) materials more than 2 feet thick will adversely affect the vertical basement walls. Vertical pressures resulting from expansive (shrink-swell) materials below the footings must also be considered.

3. Dwelling with concrete slad flooring: It is assumed these structure will be constructed with normal spread footings placed at a depth of 2 feet. It is also assumed the surface 6 inches will be removed, and the slad and select base material placed upon the soil.

Together with the above specified assumptions, it is also assumed all excavated materials will be used as backfill material around the footings and walls.

Guide Sheet 6a -- Soil Limitation Ratings for Dwellings Without Basements

Item Affecting Use	Degree of Limitation		
	Slight	Moderate	Severe
Seasonal water table (seasonal means for 1 month or more)	Below a depth of 40 inches.	Between 20 to 40 inches.	Above a depth of 20 inches.
Flooding	None	None	Rare or common.
Slopes 2/	0-8 pct.	8-15 pct.	> 15 pct.
Shrink-Swell potential	Low	Moderate	High
Unified soil classification of the foundation soil at 2 feet.	GW, GP, SW, SP GM, GC, SM, SC	CL and ML	CH, MH, OL, OH and Pt
Depth to bedrock or hardpan. 3/, 4/	> 40 in.	20 to 40 inc.	< 20 in.
Bouldery class 5/	0	1	2,3,4, and 5
Stones and cobbles (Vol)	< 15 pct.	15 to 35 pct.	> 35 pct.

1/ Some soils give" limitation ratings of moderate or severe may he good sites from the standpoint of esthetics but require more site preparation or maintenance.

2/ Reduce slope limits 50 percent for those soils susceptible to hillside slippage.

3/ Reflects ease of excavation and site preparation. If bedrock is soft or hardpan is thin enough so that it can be dug with light power equipment, reduce ratings of moderate and severe by one step.

4/ Lithology of the bedrock is not considered in this interpretation. On-site geologic investigation is recommended where bedrock, such as mica schists, serpentine, etc., is encountered, especially in areas having slope.

5/ For class definitions see Soil Survey Manual, pp. 216-223.

Attachment 1

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Guide Sheet 6b -- Soil Limitation Ratings for Dwellings with Basements

Item Affecting Use	Degree of Limitation 1/ Slight	Moderate	Severe
Seasonal water table (seasonal means for 1 month or more)	Below 72 in.	Between 40 and 72 in.	Above 40 in.
Flooding	None	None	Rare or common.
Slopes 2/	0-15 pct.	15-25 pct.	> 25 pct.
Shrink-swell potential	Low	Moderate	High
Unified soil classification of the foundation soil at 5 feet.	GW, GP, SW, SP, GM, GC, SM, SC	CL and ML	CH, MH, OL, OH and Pt
Depth to bedrock or hard an 3/, 4/	> 60 in.	40-60 in.	< 40 in.
Bouldery class 5/	0	1	2, 3, 4, and 5
Stones and cobbles (Vol)	< 15 pct.	15 to 35 pct.	> 35 pct.

1/ Some soils given limitation ratings of moderate or severe may be good sites from the standpoint of esthetics but require more site preparation or maintenance.

2/ Reduce slope limits 50 percent for those soils susceptible to hillside slippage.

3/ Reflects ease of excavation and site preparation. If bedrock is soft or hsrdpsn is thin enough so that it can be dug with light power equipment, reduce ratings of moderate and severe by one step.

4/ Lithology of the bedrock is not considered in this interpretation. On site geologic investigation is recommended where bedrock, such as mica schists, serpentine. etc, is encountered, especially in areas having slope.

5/ For class definitions see Soil Survey Manual, pp. 216-223.

Guide Sheet 6c -- Soil Limitation Ratings for Dwellings with Slab Construction[1/]

Item Affecting Use	Degree of Limitation[2/]		
	Slight	Moderate	Severe
Seasonal water table (seasonal means for 1 month or more)	Below a depth of 40 inches.	Between 20 to 40 in.	Above a depth of 20 in.
Flooding	None	None	Rare or common
Slopes	0-4 pct.	4-8 pct.	> 8 pct.
Shrink-swell potential	LOW		
Unified soil			
Depth to bedrock or hardpan[3/, 4/]			

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Guide Sheet 7 -- Soil Limitation Ratings for Trench-Type Sanitary Landfill&'

Items Affecting Use	Degree of Soil Limitation		
	Slight[2/]	Moderate	Severe
Depth to seasonal high water table	Not class determining if more than 72 inches.		< 72 inches
Flooding	None	Rare	Common
Permeability[3/]	< 2.0 in./hr.	< 2.0 in./hr.	> 2.0 in./hr.
Slope	0-15 pct.	15-25 pct.	> 25 pct.
Unified classification (dominant to a depth of 60^in.)` [4/]	CL and ML GM, GC, SM, SC	GW-GM or GC, GP-GM or GC, SW-SM or SC, SP-SM or SC	CH, MH, OL, OH and Pt
Depth to hard bedrock or [5/]	> 72 in. >60 i(>)Tc 2.8933 T12q 54003 0 Td40- (60 i(>)Tj ET q .36000959 0 0 4.080001443.7.5	> 72 in.	< 72 in.

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Guide Sheet 8. -- Soil Limitation Ratings For Area-Type Sanitary Landfills

Item affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to seasonal high water table	> 60 in.	> 60 in.	< 60 in.
Flooding	None	None	Any
Permeability 1/	Not class determining if less than 2 in./hr		> 2 in./hr
Slope	o-g pct.	g-15 pct.	> 15 pct.

1/ Reflects ability of the soil to retard movement of leachate from landfills. In aridic or torric regimes disreagrd permeability classes as a criteria. Intergrade moisture regimes (xeric or ustic-aridic and aridic-xeric or ustic) upgrade severe to moderate.

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Guide Sheet 9 -- Suitability Ratings of Soils as Sources of Cover Material for Area-Type Sanitary Landfills

Item Affecting Use	Degree of Soil Suitability		
	Good	Fair	Poor
Moist Consistence	Very friable, friable	Loose, firm	very firm, extremely firm
Thickness of material (usually uppermost part of profile)	> 40 in.	20-40 in.	< 20 in.
Slope	o-15 pct.	15-25 pct.	> 25 pct.
Depth to seasonal high water table	> 40 in.	20-40 in.	< 20 in.
Stones and cobbles (Vol)	< 15 pct.	15 to 35 pct.	> 35 pct.
Unified classification	GM, GC, SM, SC, CL, ML	GW-GM or GC, GP-GM or GC. SW-S" or SC, SP-SM or SC	CH, MH, OL, OH, Pt GW, GP, SW 1/, and SP
Bouldery class 2/	0	1, 2	3, 4, and 5

1/ Suggest footnotes

2/ For class definitions are Soil Survey Manual, pp.216-223.

Attachment 1

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Guide Sheet 10. -- Soil Limitation Ratings for Local Roads and Streets

Item Affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Depth to seasonal high water table	> 40 in.	20-40 in.	< 20 in.
Flooding	None	Rare	Common
Slope	0-8 pct.	8-15 pct.	> 15 pct.
Depth to bedrock 1/	> 40 in.	20-40 in.	< 20 in
Subgrade Unified soil classification	GW, GP, SW 2/, SP 2/, GM, GC 2/ SM 2/, SC 2/	CL, ML	CH, MH 3/, OH, OL, Pt
Shrink-swell potential	LOW	Moderate	High
Susceptibility to frost action 4/	LOW	Moderate	High
Bouldery class 5/	0	1, 2	3, 4, and 5
Stones and cobbles (Vol)	< 15 pct.	15-35 pct.	> 35 pct.

1/ If bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery, reduce limitation ratings of moderate and severe by one step.

2/ Downgrade limitation rating to moderate if content of fines is more than about 30 percent.

3/ Upgrade limitation rating to moderate if NH is largely kaolinitic, friable, and free of mica.

4/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. See section "Potential Frost Action" for guidance in determining classes.

5/ For class definitions see Soil Survey Manual, pp. 216-223.

Attachment 1

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Guide Sheet 11. -- Suitability Ratings of Soils as Sources of Road Fill

Item Affecting Use[1/] Degree of Soil Suitability

Attachment 1

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Guide Sheet 12. -- Suitability Ratings of Soils as Sources of Sand and Gravel

Soil Groups in Unified System	Probable Source		Improbable Source	
	Good	Fair	Poor	Unsuited 5/
	SW 1/	SW-SM 1/	SM 3/	All
	SP 1/	SP-SM 1/	SW-SC 3/ SP-SC 3/	other
	GW 2/	GP-GM 2/	GM 4/ GP-GC 4/	groups
	GP 2/	GW-GM 2/	GW-GC 4/	

1/ For sand
In rating for gravel --
Rate as unsuited if more than 75% passes #4 sieve.
Rate same as for sand but specify "after sieving" if 50-75% of total (including material larger than 3") passes #4 sieve.

2/ For gravel
In rating for sand --
Rate as unsuited if material passing #4 sieve but larger than #200 sieve is less than 25% of total (including material larger than 3").
Rate same as for gravel but specify "after sieving" if material passing #4 sieve but larger than 8200 sieve is 25% or more of total (including material larger than 3").

3/ For sand
In rating for grave1 --
Rate as unsuited if more than 75% passes # 4 sieve.

4/ For gravel
In rating for sand --
Rate as unsuited if material passing # 4 sieve but larger than 8200 sieve is less than 25% of total (including material larger than 3").

5/ Also rate as unsuited, soils having more than 50% cobble or more than 25% stones, regardless of the Unified group (explain rating in footnote).

Other

Guide sheet 13 -- Suitability Ratings of Soils as Sources of Topsoil.

Add SAR and ESP to items affecting use. SAR entries: < 13 for Good and Fair; > 13 for Poor. ESP entries: < 15 for Good and Fair; > 15 for Poor.

Guide sheet 14 -- Characteristics of Materials for Compacted Embankments.

Break Unified groups for which a range in values is given by adding USDA texture class, percentage passing sieves, LL, or PI so one rating can be given in each column.

Add criteria for soil slippage potential.

Add hydrologic soil group criteria after definitions of the groups have been refined and the groups are mutually exclusive and all inclusive.

Corrosivity criteria not acceptable to many.

Delete references to Unified groups on pages 15 and 16 of Guide for Interpreting Engineering Uses of Soils (No consistent correlation between Unified classes and shrink-swell potential.)

Reconsider ratings for potential frost-action. The present guide is misleading to some and implies a degree of precision that is difficult if not impossible to justify.

A number of guides and rules of thumb for evaluating soils for various purposes are available. These include procedures for estimating settlement potential of soils for low buildings; estimating liquid limit, plasticity index, and shrink-swell from percent clay (both carbonate and noncarbonate); and many others. These should be considered for inclusion in a revised Guide.

All NCSS reports in which soil limitation and suitability ratings are given should contain a statement explaining that the ratings are tentative and subject to change. Additional information based on research and experience may indicate that changes are warranted, (The ratings are based on present knowledge of soil behavior which in many cases is far from complete. For example, considerable discussion took place during the conference on the reason for giving ML soils a moderate limitation rating for dwellings. Some though ML soils should be rated slight; others thought severe. Apparently some ML soils tend to collapse under load. Whether this is a widespread occurrence is not known. One committee member stated: "I would like to see the Service initiate an evaluation program of all criteria that would include field interviews with contractors, builders, and local agency people. The purpose would be to ascertain the significance of (1) the soil features rated; (2) the break points between rating groups; and (3) other features that may influence the ratings.")

Example 1

GUIDELINES FOR OVERCOMING SOIL LIMITATIONS FOR SEPTIC TANK ABSORPTION FIELDS

Item Adversely Affecting Use	
A. Permeability class Hydraulic conductivity Percolation rate	1. Add pervious fill material.
	2. If soil layers with rapid and moderately rapid permeability rates are at depths of 48 to 72 inches, and less permeable material is overlying, it may be feasible to excavate into the more permeable material, fill with fine gravel up to the depth of the drain tile, place tile and appropriate gravel filter blanket, and complete fill with available material.
	3. Use additional amount of tile line.
	4. Reduce allowable housing density. Determine specifics with local Health Dept.
B. Depth to seasonal high water table	1. Add fill as described in A-1.
	2. Install drainage system to lower water table, if feasible.
C. Flooding	1. Install flood protection.
D. Slope	1. Deep, uniform-textured, non-layered soils may permit some leveling.
	2. Use extreme care to insure maintenance of grade on tile line.
E. Depth to hard rock - impervious materials	1. Add fill as described in A-1
	2. Use additional amount of drain tile so as to minimize volume of effluent per unit of distance.
F. Stoniness	1. Remove stones.
	2. Add fill as described in A-1.
G. Rockiness	1. Add fill as described in A-1
	2. Lay tile in deeper soil areas around outcrops.
	3. Use additional tile line so as to minimize volume of effluent per unit of distance.

Attachment 2, Example 2

OVERCOMING SOIL LIMITATIONS FOR SEWAGE LAGOONS
(Technique & procedures given assume all other limitations are slight)

ITEMS AFFECTING USE	SLIGHT	MODERATE	SEVERE
Depth to water table	Lagoon bottom must be above seasonal highwater table	Lagoon bottom must be above seasonal high water table. Cut & fill construction may be needed.	Locate lagoon above [illegible] ground elevations.
Permeability	Artificial lining of lagoon may be necessary where water supply is located closer than 300 feet. One foot of compacted GC, SC, CL, or CH soil acceptable.	One foot of compacted GC, SC, CL, or CH soil or artificial lining required where potable water supply located within 300 feet. Underdrainage system for seepage collection is an acceptable alternate.	3 feet of compacted [illegible] CL, or CH soil or artificial [illegible] quired over entire interio[illegible] of lagoon. CH material should [illegible]ed with 12" of coarser material [illegible] tinuously submerged to preven[illegible]ation. Underdrainage for s[illegible]ollection essential.
Depth to Bedrock	Maintain 3 ft. of natural soil between finished lagoon geometry and bedrock. Install underdrains unless natural soils are GC, SC, CL or CH.	Import, place, & compact 3 ft. of GC, SC, CL, or CH soil between finished lagoon geometry and bedrock. Fill material other than as above wil require artificial lining or of soil above. CH soil should be covered with 12" coarser material or continuously submerged.	Locate lagoon above [illegible] ground elevation. Place 3 [illegible] compacted GC, SC, CL, or CH s[illegible]en finished lagoon sur[illegible]d bedrock. Coarser soils requi[illegible]or artificial lining
Slope		Use compacted impervious material in the fill or artificial lining. Downslope interceptor may be required.	Use compacted imper[illegible]ll material or artificial linin[illegible] slope interceptor drain requir[illegible]
Coarse Fragment < 10" % by volume	Removal from fill materials may be necessary. Excavation may require special equipment.	Removal from fill materials necessary. Special construction equipment may be required. Artificial linings may require importing bedding material.	Removal from fill m[illegible] necessary. Special constructio[illegible]ent necessary. Artificial lin[illegible] require importing bedding m[illegible]

Attachment 2, Example 2 (cont'd)

OVERCOMING SOIL LIMITATIONS FOR SEWAGE LAGOONS
(Technique & procedures given assume all other limitations are slight)

ITEMS AFFECTING USE	SLIGHT	MODERATE	SEVERE
% Surface area covered by coarse fragments < 10"	–	Remove coarse fragments from foundation area of fills.	Remove coarse fragments from foundation area of fills.
Organic matter	Avoid placing soils with organic matter in fills.	Avoid soil with organic matter in fills or foundation. Analyses of potential reaction of lagoon water with organic material or lining material desired.	Avoid soil with organic matter in fills or foundations. Analyses of potential reaction of lagoon water with organic or lining material required.
Flooding	–	–	Flood proof against at least 1% event by diking.
Soil groups	–	Adequate compaction of fills is imperative. Artificial lining or soil lining with GC, SC, CL, or CH may be necessary.	Import impervious soils (GC, SC, CL, CH) for lining. Artificial lining requires SW or SP bedding. OL, OH & Pt not to be used as foundation or fill.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

San Diego, California
January 21-25, 1974

REPORT ON COMMITTEE 9
Classification of Organic Soils and Their Interpretations

In 1972 a National Task Force on Organic Soils was organized and charged with preparing suitability groupings of organic soils and interpretative guides for agriculture forestry, engineering, wildlife, and commercial uses Of peat. The report of the Task Force was presented to the National Soil Survey Work-Planning Conference in January 1973, and was circulated as an attachment to the Proceedings of that conference. The principal function of the Organic soils committee* of the regional work-planning conference* this year is to review the Task Force report and the guides that have been proposed.

In preparing its suitability grouping of organic soils for agriculture, the Task Force relied largely on a "Use Capability Classification for Organic Soils" developed in Ontario. In this system suitability ratings are determined by assigning "penalty points" to soil characteristics that can adversely affect agricultural potential after drainage, and adding together all of the penalty points for any one soil to arrive at its over-all rating. Seven suitability groups, defined by accumulated point totals, are proposed. Each soil or field is also given a separate "development difficulty" rating by a similar system of penalty points. Recommendations for development of a *it* are then based on consideration of both of these ratings.

The penalty point system was also used by the Task Force to evaluate the suitability of organic soils as sites for small building* with basements. Other engineering interpretations were not attempted, but these could be developed by the same method of assigning penalty points to appropriate soil feature*.

The Forestry committee of the Task Force preferred a different approach, in which the overall rating of a soil for wood production is based on the most limiting factor or factors rather than on a summation of limiting factors as expressed by penalty points. This is closer to the method that has been used traditionally by the Soil Conservation Service in evaluating soils for various uses.

Agriculture

A principal objection to the penalty point method of evaluating the suit-ability of organic soils for agriculture is that, if adopted, no direct comparison would be possible between suitability classes for organic soils and the standard capability classes for mineral soils. It is recognized that some of the unique characteristics of organic soils--subsidence and decomposition after drainage, for example--make it necessary to use criteria in evaluation that are different from those used for mineral soils, but a majority of the committee agreed that an attempt should be made to prepare a guide to placement of organic soils in the capability classification. The guide we have prepared (page 3) is based on essentially the same assumptions and in general uses the same criteria as the Task Force suitability grouping. It can be treated as either an alternative or a supplement to the penalty point system. The proposed guide does not include some of the features used by the Task Force in determining the "development difficulty' rating. We feel that these criteria can seldom be applied to a series or phase as a whole, but must be determined separately for each field or drainage project.

It is likely that any general guide of this kind will need to be modified to meet local conditions. In California, for example, some areas of intensively cultivated organic soils are now below sea level and it is becoming increasingly difficult to maintain levees and a uniform surface level. In other coastal areas, brackish water may impede or prevent development. It will be necessary to develop additional local criteria for such situations. Flooding is not recognized as a limiting feature in the guide, though perhaps it should be. Maximum capability classes based on degree of flooding hazard could be determined locally.

In the existing capability classification, virtually all organic soils except Folists would be assigned to the w subclass. It is obvious, however, that more than one subclass will be required to describe the kinds of limitation responsible for downgrading any organic soil. For best compatibility with the present classification, we propose two letter subclass symbols for organic soils (except in the case of the Folists, where the single letter s may be sufficient); the first letter would always be w and the second a letter reflecting the major limitation other than wetness. It would be possible to use letters for each limiting feature--f for woody fragments, m for mineral layers, d for shallowness over an unsuitable substratum, etc.--but for the sake of simplicity the following may suffice:

- wc - climatic limitation
- ws - soil limitation
- wr - slope limitation

The wr symbol probably would be needed only in high rainfall areas on the Pacific coast.

Engineering

This committee has no comments on the penalty point values assigned by the Task Force to soil features considered in interpretations for small buildings with basements, except that in general the values appear to be reasonable. We agree with the Task Force that, for engineering interpretations, a single rating system should be used for both organic and mineral

PROPOSED GUIDE TO CAPABILITY CLASSES, ORGANIC SOILS

Mesic (or warmer) Temperature Regime

Limiting Feature	Capability Class				
Woody fragments (volume)	<1%	1-5%	>5%		
Wood layers (thickness)	<8 cm	>8 cm			
Mineral or limnic layers 1/	<5 cm	5-30 cm			
Degree of decomposition	Saprists Hemists	Nonsphagnic Fibrists	Sphagnofibrists		Folists
Underlying materials (Terric or lithic subgroups only)	Loamy Clayey	Sandy Diatomaceous earth Volcanic ash Marl	Coprogenous earth Skeletal	Fragmental Bedrock	
Salinity 2/	<4 mmhos/cm	4-8 mmhos/cm	8-16 mmhos/cm	>16 mmhos/cm	
Sulfur	<0.4%		0.4-0.75%	>0.75%	
Slope	<6%	6-12%	12-20%		'20%

1/ Applies to subsurface and bottom tiers only
2/ One class lower if mineral or limnic layers are present within 125 cm.

Frigid Temperature Regime

All categories one class lower (IV to VI considered one class difference)

Cryic Temperature Regime

All categories two classes lower (or more under adverse climatic conditions)

Pergelic Temperature Regime

All soils in Class VII (or class V)

soils and that any system that is developed must be fully tested in the field before adoption.

Forestry

The "Use Potential Groups for Forestry" proposed by the Task Force evaluates soils exclusively on the basis of their potential productivity. one committee member has suggested that this is not adequate, in that manage-, ment problems are not considered. Subgroups or subclasses probably would be desirable to indicate major difficulties that may be encountered in harvesting and any potential damage to the soils. As in the agricultural and engineering groupings, ratings of organic soils should be directly comparable with those of mineral soils though the criteria used in arriving at the ratings may be different.

Subsidence

The National Task Force accepted without change the subsidence potential classes developed several years ago in Louisiana. This action was recommended at the last western regional conference.

It is apparent that much additional interpretive work is required for organic soils. We recommend that both the National Task Force on Organic soils and this regional committee be continued.

G. M. Kennedy
W. D. Nettleton
J. J. Rasmussen
S. Rieger, Chairman

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

DESCRIPTION OF THE INTERNAL PROPERTIES OF SOILS

COMMITTEE 10

The committee was given three specific charges and the report is organized to correspond with the charges.

Charge I - Review the particle size classes in the draft chapter of the soil survey manual and prepare comments.

The manual and proposed changes are:

	Manual	Proposed
A. Sand --------------------	2 - 0.05 mm	2 - 0.1 mm.
1. Very coarse sand -----	2 - 1. mm.	2 - 1. mm.
2. Coarse sand ----------	1 - 0.5 mm.	1 - 0.5 mm.
3. Medium sand ----------	0.5 - 0.25 mm.	0.5 - 0.25 mm.
4. Fine sand ------------	0.25 - 0.10 mm.	0.25 - 0.1 mm.
5. Very fine sand -------	0.10 - 0.05 mm.	- -
B. Silt ---------------------	0.05 - 0.002 mm.	0.1 - 0.002 mm.
1. Coarse silt ----------	- -	0.1 - 0.02 mm.
2. Fine silt ------------	- -	0.02 - 0.002 mm.
C. Clay ---------------------	Less than 0.002 mm.	Less than 0.002 mm.

Comments:

The committee concurred that it would be desirable to have an agreement between textural classes and family textural boundaries. They approved the proposed changes with the exception that the limit between sand and silt be at 0.074 mm.

Some committee members expressed concern in the use of the terms coarse, medium and fine to express particle size in one instance and percent sand in another. The committee did not have an alternative suggestion but thinks this is confusing.

Since the setting of the textural class limits is largely in response to the effects of applied soil science some of the committee throught there should be an evaluation period to compare the manual with the proposed. See comments charge II.

Charge II - The Soil Science Society has proposed a limit between sand and silt of .0625 mm. This is midway between the engineers limit of 0.074 and soil survey of 0.05. Prepare recommendations for conference approval.

The committee recommends in as much as many soil interpretations are related to the engineering classification, the soil survey should adopt the .074 mm. boundary between sand and silt.

Comments:

The committee members did not like the .0625 mm. boundary and prefer to leave the boundary at .05 mm. rather than make this change.

Since the family groupings are based on soil properties significant to applied soil science and suggested textural classes are related to these, the majority of the committee recommended the change to 0.074 mm. as the sand-silt boundary. They consider it is an appropriate time to make the change.

Charge III - Review consistence terms and definitions in the draft of Chapter 5 of the soil survey manual and prepare comments.

Comments:

1. The terms and tests have not had very wide circulation, consequently, field testing has been very limited and ability for field men to apply the tests and the terminology is not known. Field testing should be done before application is required.

2. The terms do not appear to include terms to adequately describe thixotropic soils. Presumably fluid classes may include these. One committee member recommended terms as defined in "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii".

   Weakly smeary. -- Under strong pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears. After the soil smears, there is little or no evidence of free water on the finger.

   Moderately smeary. -- Under moderate to strong pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears and is slippery. After the soil smears, there is evidence of free water on the fingers.

   Strongly smeary -- Under moderate pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears and is very slippery. After the soil smears, free water is easily seen on the fingers.

3. Until the metric system is more operational, English equivalent measurements should be shown in parentheses.

4. Some consideration be given to development of an instrument for field use to determine fluidity.

5. Additional classes for cementation, brittleness and penetrometer ratings.

6. Chapter arrangement needs further study.

7. Progress in the right direction. Methods and terminology will help to quantify consistence terms.

The committee completed this assignment but other appropriate charges concerning internal soil properties may need committee action.

The report of the committee was approved and accepted by the conference membership.

Committee Members

T. B. Hutchings, Chairman
O. F. Bailey
H. Ikawa
A. R. Southard
G. H. Simonson
F. F. Peterson
D. F. Bauer
C. W. Guernsey
A. O. Ness
J. E. Brown

NATIONAL COOPERATIVE SOIL SURVEY

Western Regional Conference Proceedings

Honolulu, Hawaii
January 23-28, 1972

Copy

- Williams -

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Proceedings of ...

WESTERN REGIONAL TECHNICAL WORK- PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

Honolulu, Hawaii
January 23-28, 1972

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

Honolulu, Hawaii
January 23-28, 1972

REPORT OF CONFERENCE PROCEEDINGS

The Western Regional Technical Work-Planning Conference of the Cooperative Soil Survey was held in Hilo and in Honolulu, Hawaii, on January 23-28, 1972.

The conference commenced with a field tour, conducted by Harry Sato and Ernest Robello of the Soil Conservation Service, and Drs. Ike Ikawa and Goro Uehara of the University of Hawaii, on the island of Hawaii on January 23 and 24, 1972. Participants saw the nature of parent material at zero time, the effect of climate on vegetation in the formation of Tropofolists, the effect of rock texture on soil development, and the influence of climate on the morphology and classification of Andepts.

The meeting was continued in Honolulu on January 25 with Fred Houghton, State Conservationist, and Dean Wilson of the College of Tropical Agriculture, University of Hawaii, welcoming the group to the Aloha State.

Other speakers and their contributions are as follows:

J. K. Williams, Principal Soil Correlator, West Regional Technical Service Center, Portland - Recent Developments in Soil Survey in the Western Region.

William Johnson, Deputy Administrator for Soil Surveys - National Soil Survey Program.

Professor Robert Fox, Department of Agronomy and Soil Science, University of Hawaii - Slide presentation on the fertility problems in the tropics; role of silica in Hawaiian soils.

R. [illegible], Bureau of Land Management - Determination of Grazing Condition Classes.

Dr. L. Bartelli, Principal Soil Correlator, South Regional Technical Service Center, Ft. Worth - Use of ADP at the Ft. Worth Center. Samples of how ADP is used to produce tables for the soil survey report.

Dr. G. D. Swindale, Associate Director, Agricultural Experiment Station, University of Hawaii - Soil Data Processes for Agricultural Development. Importance of "[illegible]" experiments; also described a method of storing soil survey data in the form of cubic polynomial equation. Data can be stored in the form of this equation and retrieved by solution of this equation to permit delineation of boundaries.

Dr. J. McClelland, Principal Soil Correlator, Mid-West Regional Technical Service Center, Lincoln - Certification of Soil Surveyors and Classifiers.

Henry [illegible], Head, Cartographic Unit, Portland - Latest cartographic techniques and services available to the Western States.

Dr. Austin [illegible], Dean Austin A. Williams - Land Use Law in Hawaii.

The group went on a field trip on Oahu to examine the Molokai, Wahiawa and Manana soils. Robello, Ikawa and Uehara discussed the morphological, chemical, physical and mineralogical properties of these Oxisols and Ultisols.

A short business meeting was held to determine the location of the next meeting place in 1974. Tucson, Arizona, an alternate site to Hawaii in 1972, was considered but not chosen when learned that Dr. Hendricks will be on sabbatical leave then. Dick Huff invited the group to San Diego, California, since the project on land-use planning based on the soil survey for the city there is nearly completed. The group voted to accept the invitation.

COMMITTEE MEMBERSHIP ASSIGNMENT
WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
FOR SOIL SURVEY
HONOLULU, HAWAII
JANUARY 23-28, 1972

Committee 1 - Application of Soil Classification System

J. W. Rogers, Chairman
J. U. Anderson
J. C. Brown
O. V. Chenoweth
L. D. Giese
T. B. Hutchings
R. C. Kronenberger
R. F. Mitchel

Committee 2 - Handling Soil Survey Data, Soil Survey Laboratory Investigations and Benchmark Soils

A. R. Southard, Chairman
J. U. Anderson
L. A. Bronaugh
W. L. Colwell
K. W. Flach
H. A. Homan
D. Hendricks
E. K. Knox
G. A. Nielson
P. C. Singleton
G. Uehara

Committee 3 - Soil Survey for Range and Forest Soils

J. A. Williams, Chairman
L. A. Bronaugh
J. Hagihara
M. S. James
L. D. Linnell
S. Rieger
A. C. Sherrell
G. H. Simonson
W. A. Wertz

Committee 4 - Climate in Relation to Soil Classification and Interpretation

R. J. Arkley, Chairman
A. J. Cline
R. C. Kronenberger
C. A. Lowitz
E. M. Richlen
J. A. Williams

Committee 5 - Environmental Soil Science

K. W. Flach, Chairman
R. J. Arkley
T. Collins
D. L. Gallup
L. D. Giese
J. Hagihara
D. M. Hendricks
T. B. Hutchings
V. C. Link
L. C. Leifer
L. Lund
J. T. Maletic
F. F. Peterson
S. Rieger
A. R. Southard
J. C. Stevenson

Committee 6 - Engineering Application and Interpretation

A. R. Hidlebaugh, Chairman
J. F. Corliss
R. L. Fox
K. D. Heil
M. S. James
L. N. Langan
C. A. Lowitz
E. A. Naphan
G. A. Nielson
W. D. Nettleton
J. C. Stevenson
W. A. Wertz
J. A. Williams

Committee 7 - Soil Interpretations at the Higher Categories of the Soil Classification System

E. L. Spencer, Chairman
J. P. Anderson
O. V. Chenoweth
A. J. Erickson
M. A. Fosberg
L. N. Langan
L. D. Linnell
E. M. Richlen
J. W. Rogers
W. A. Starr
L. Farstad

Committee 8 - Soil Survey Procedures

V. C. Link, Chairman
D. F. Bauer
L. A. Bronaugh
J. F. Corliss
A. J. Erickson
M. A. Fosberg
W. W. Hill
H. A. Homan
A. C. Sherrell

Committee 9 - Soil Family Criteria

T. B. Hutchings, Chairman
D. F. Bauer
J. C. Brown
R. C. Huff
E. K. Knox
R. F. Mitchel
P. C. Singleton

Committee 10 - Histosols

S. Rieger, Chairman
J. C. Brown
A. R. Hidlebaugh
R. C. Huff
E. K. Knox
L. C. Leifer
W. D. Nettleton

WEDNESDAY, JANUARY 26 Chairman: E. Spencer

8:00 - 9:30	Report by Committee 3 - Soil Survey for Range and Forest Soils - J. A. Williams
9:30 - 10:00	Determination of Erosion Condition Classes - R. Kuhlman
10:00 - 10:15	Recess
10:15 - 10:30	Business meeting
10:30 - 12:00	Report by Committee 4 - Climate in Relation to Soil Classification and Interpretation - R. Kronenberger for R. Arkley

Chairman: O. Chenoweth

1:15 - 2:45	Report by Committee 5 - Environmental Soil Science - K. Flach
2:45 - 3:00	Recess
3:00 - 4:30	Report by Committee 6 - Engineering Application and Interpretation - A. Hidlebaugh

THURSDAY, JANUARY 27 Chairman: H. Ikawa

8:30 - 4:00	Field trip - Oxisols and Ultisols in the Wahiawa Plateau 1. Examine Manana, Honouliuli, Molokai, Wahiawa and Manana series. 2. Influence of land forms and climate on morphology and classification.

Chairman: L. Swindale

6:00 PM	Banquet - Ala Moana Hotel Speaker: D. Austin - Land Use Law in Hawaii

FRIDAY, JANUARY 28 Chairman: G. Nielson

8:00 - 9:30	Report by Committee 7 - Soil Interpretations at the Higher Categories of the Soil Classification System - E. Spencer
9:30 - 10:00	Soil Data Processes for Agricultural Development - L. Swindale
10:00 - 10:15	Recess
10:15 - 12:00	Report by Committee 8 - Soil Survey Procedures - V. Link

Chairman: R. Hoff

1:15 - 2:45	Report by Committee 9 - Soil Family Criteria - J. Hutchings
2:45 - 3:00	Recess
3:00 - 4:30	Report by Committee 10 - Histosols - S. Rieger
4:30 - 5:00	Conference Summary - L. Swindale

APPLICATION OF SOIL CLASSIFICATION SYSTEM

Committee I

Charge No. 1: Consider and submit specific recommendations about the use of the depth of the water table to drainage class.

The committee report does not offer specific recommendations. Instead, a proposal is presented for discussion.

The committee agrees that drainage classes as now described in the Soil Survey Manual should be dropped. In their place "Soil Water Regimes" as suggested and outlined in the 1971 Proceedings of the National Technical Work Planning Conference of the Cooperative Soil Survey should be adopted.

In the 1971 National Technical Work Planning Conference Report it is recommended that soils be classified broadly as "wet" or "non-wet" soils. The charge to Committee I concerns, then, those soils classified as "wet."

The committee is in agreement that depth to water table and duration, being a property of soils, should be tied to classes in the Soil Taxonomy so that reasonable consistence be achieved over broad areas.

The following water table-drainage class criteria is submitted by the committee for discussion purposes:

Wet Soils

Modifiers	Taxa
Continuously saturated--saturated more than 10 months of the year within 20 inches of the surface.	Hydraquic
Extremely wet, very wet--saturated 6 to 10 months within 20 inches of the surface	Aquic Suborders
Moderately wet--saturated 3 to 6 months within 20 inches of the surface	Aeric subgroups of Aquic suborders
Slightly wet--saturated less than 3 months within 20 inches of the surface.	Aquic subgroups

The committee recognizes there are some problems with the suggested criteria. One, for example, is the soils that are well drained in their natural state but have water tables at varying depths and lengths of time due to excess water from irrigation.

The committee emphasizes the need for describing water tables in detail, in terms of kind, depth, duration and season, at the mapping unit level or series level if the characteristics apply to all mapping units.

During the group discussion several points were brought to light reflecting problems in trying to relate depth of water table to drainage class to taxa. Some examples of the problems pointed out are: some soils having water table in their natural state are now drained; some soils with high water tables have adequate oxygen supplies; some drained soils have better subsequent drainage characteristics than some soils that are not naturally wet; some soil having high water tables have morphology indicative of being well drained; there are strong regional differences in season of high water tables.

On the basis of the discussion, the group agreed that depth of water should not be definitive of drainage class and taxa. It was agreed that water tables need to be better described in terms of depth, season, and duration.

The committee and group agreed to deleting the information on depth and duration of water tables in the proposal.

It was recommended to revise in the proposal under "Modifiers" the "continuously saturated" to "extremely wet" and the "Extremely wet, very wet" to "very wet." The committee and group approved this recommendation.

Charge No. 2: React to recommendation 5 of National Committee 4 (Application of the Soil Classification System) on the names of taxa that are used in names of mapping units in detailed surveys.

The committee agreed with all seven of the items as presented by the National Committee. Item "C" was not favored by the committee which is in agreement with the non-supporting position of the National Committee.

Some of the group supported the proposal in item "C". A vote was taken and it was defeated 20 against and 10 in favor.

The committee report was accepted as altered through discussion.

Committee: J. W. Rogers, Chairman
J. E. Brown
O. V. Chenoweth
T. B. Hutchings
R. C. Kronenberger
L. D. Giese
J. C. Anderson
R. F. Mitchel

WESTERN REGIONAL SOIL SURVEY WORK-PLANNING CONFERENCE
HONOLULU HAWAII JAN. 25-28, 1977.
REPORT-COMMITTEE #2

Handling Soil Survey Data, Soil Survey Laboratory Investigations and Benchmark Soils

Dr. Klaus Flach reported on activities of Soil Survey Laboratory at Riverside and urged careful planning to include the Laboratory in field sampling schedules. Dr. Gerald Nielsen reported on the AMP program in Montana. The remainder of the committee report was devoted to distributing the assembled list of benchmark soils, their classification and status of characterization. The listing of the number of families in each state is as follows. The summary data will be available in the office of the Principal Soil Correlator, West Region, and the Soil Survey Laboratory in Riverside.

State	Families
Alaska	14
Arizona	30
Colorado	26
Hawaii	20
Idaho	26
Montana	28
Nevada	39
Oregon	26
Utah	21
Washington	15
Wyoming	23

Committee Membership:

A. R. Southard, Chairman
W. J. Colwell
K. W. Flach
D. Hendricks
G. A. Nielson
P. C. Singleton
E. K. Knox
S. Uehara
T. L. Anderson
H. Homan

SOIL SURVEY FOR RANGE AND FOREST LANDS

Committee 3

Thereport of the previous committee on "soil Survey for Range and Forest Soils". and the report of the national committee on "Forest soils" were reviewed by the committee chairman. From items mentioned in these reports and the charges supplied by the Steering Committee, a letter was sent to the committee members outlining the charges to be considered. For each charge the chairman posed several questions to be answered by the committee membership.

The committee charges established by the Steering Committee are listed below:

1. Intensity of mapping and details of investigation.

2. Kinds of mapping units.

3. Size of mapping units.

4. Kinds of interpretations needed and kinds that can be made at different intensities.

5. Explore better methodology in making these surveys.

The results of the committee's deliberations on each of the several charges are now discussed.

Charge 1 - Intensity of mapping and details of investigation.

This charge is a continuation of one of the charges the committee faced at the Las Cruces Conference in 1970. The 1972 committee has considered this charge on the basis of three questions posed by the chairman.

1. In what kind of problems do you feel that detailed surveys are required? The majority of the committee indicated that detailed surveys on range and forest lands are needed for those areas subject to intensive use or intensive management. This would include areas selected for specific treatment measures such as vegetation conversion projects, recreation sites, rehabilitation and restoration projects and the like. Two committeemen thought the detailed surveys are always needed.

2. Will reconnaissance surveys provide the needed answers? Most of the committee answered yes to this one when the area to be handled was one of extensive use sod one in which the use would not change drastically in the foreseeable future. One member indicated most strongly that reconnaissance surveys would not provide the required information.

3. Does it make a difference whether the area to be surveyed is 2,"" or 20,000 acres in size? The committee is in agreement that the size of the survey area is immaterial to the problem of survey intensity. The governing feature is the expected intensity of use or management.

   It is felt of interest to include an idea presented by one of the committee and one which the chairman can fully support. Our present concept of intensities of mapping and details of investigation is outmoded. In effect we are saying we design surveys at different levels of intensity and then try to decide what kinds of uses they fit. Perhaps we should turn our thinking around to identify "problems to be solved" and then design an integrated system of land inventory to fit these needs. Our basic purpose is to provide land information for land management and for land use planning. There may be other purposes. but the land "se planning idea is central to the question of kinds of surveys. Essentially, we have four levels of planning:

   a. Planning at the national level.

   b. Regional planning and broad zoning kinds of activities.

   c. Area planning.

   d. On-the-ground project action.

   Each of these different planning levels requires information scaled to equal dimensions with the planning objective; that is, broad levels can "se and require broad level data, detailed planning requires detailed data inputs.

Charge 2 - Kinds of Mapping Units

This charge is another holdover from the Las Cruces session. The 1970 report indicates general agreement that range and forest soil mapping units should be phases or combinations of phases of series. Preference by some was expressed for mapping ""its at the family or subgroup level. Others indicated that descriptive

The committee members are not in agreement with the idea that range and forest soil mapping units should be phases of series or combinations of phases of series. Several members felt that flexibility is needed and adherence to a predetermined system limits our opportunities for improvement. Some were in favor of units at the family or subgroup level particularly in areas where the soils were little known or little studied. Others favored descriptive terminology. A particularly pointed observation brought out the fact that unit designators can range from numbers, letters, series names, names at any level in the classification to descriptive names. Another interesting observation pointed out that whether or not a soil has a pedigree (series name), does not effect how it can be used.

We were in general agreement that, where possible, classification units should be used to maintain some semblence of order. Phases of series or combinations are handy when the series are known. In the long run it is the quality of the mapping unit description that must do the job.

Charge 3 - Size of mapping units

This again is a holdover from the 1970 Conference. The 1970 report states that it is difficult to assign a definite quantative figure to the minimal sire of delineation. The report also summarized the problem thusly - the minimal size of delineation should depend on map scale, intensity of mapping, objectives of the survey, degree of contrast with adjacent soils and the relative importance of the small areas. To all of this we say Amen. In regard to sire of mapping units the chairman asked a few questions.

1. When mapping range or forested lands aren't we in actually mapping landtypes (ecologic landtypes) or sub-segments of the landscape or landtype?

2. If so, then the size of the landtype or subsection thereof delineated would govern the size of the mapping unit or would it not?

3. In making delineations shouldn't we be governed greatly by the kind of management expected an the land?

The committee were in agreement with the 1970 summary and in agreement with the questions raised by the chairman. Several members pointed out that we must have knowledge about the soils within the delineated segments of the landscape or landtypes. I believe we would all agree to this. There was complete agreement that the main factor governing the size of mapping units is the kind of management expected on the land.

Charge 4 - Kinds of interpretations needed and kinds that can be made at different map intensities.

This is an age old problem and one which we feel will not be solved overnight. It is obvious that our surveys must be interpreted for soil use and management. To be responsive to tomorrow's soil information needs, we must be continually improving the interpretative portion of our surveys today. The committee generally agrees that we need interpretations at the taxonomic level, mapping unit level and groups of mapping units. It is realized that the different agencies have different needs for kinds of interpretations. The committee mostly agrees that there is no need to make all interpretations possible for all areas surveyed. Most interpretations can be anticipated. If good reliable basic data is at hand, additional interpretations can be made as the need arises. A minority opinion was expressed to the effect that interpretations for each survey should run the full gamut.

A point that needs to be stressed is the necessity to get yield data and many other performance and behavior qualities into quantative bases rather than qualitative. This is long over due. Such informa- [redacted]

The committee has come up with a number of ideas on this subject.

1. Better photography both black and white and color.

2. Use of satellite photo coverage.

3. Remote sensing techniques.

4. Use of small but powerful land vehicles.

5. Power equipment of various kinds.

6. Use of helicopters.

This is costly but in the long run helicopter use pays dividends in areas with few roads. One member reports a 6:1 cost advantage in the use of helicopters. Another pointed up the value of the bird's eye view of the landscape.

7. Interdisciplinary approach

Better methodology must include using skills of other disciplines as the concepts Of soil inventories are broadened; for example, good geology and hydrology and plant ecology inputs. We must develop dialogue with the other disciplines. Close collaboration of

2. How do we add new small size mapping units?

CLIMATE IN RELATION TO SOIL CLASSIFICATION AND INTERPRETATIONS

Committee 4

DATA AND METHODS

The data for this study were collected in ten western states by soil scientists of the U.S.D.A. Soil Conservation Service and Forest Service and were tabulated on data forms for key-punching prepared by the author at the request of the Western Regional Technical Work Planning Conference for Soil Survey, 1970. The amount of data used is shown in Table 1.

The data forms included state; county; site identification number; soil series name; elevation; longitude; latitude; slope; aspect; surface texture; thickness of O horizon; drainage class; irrigated or not irrigated; moisture class (Udic, Ustic, or Aridic); year of measurement; plant cover; soil temperature at 20 inches (50.8 cm); and moisture status of the upper 20 inches of soil near the middle of January, April, June, July, August, October; and mean monthly air temperature for January, April, June, and October from the weather station nearest in distance and elevation.

Discrete variables were coded for computation as shown in Table 2.

Table 1

Amount of soil temperature data used

State	Number of sites	Total years recorded	Average years per site
California	125	404	3.23
Colorado	120	279	2.31
Idaho	62	168	2.71
Montana	23	61	2.77
New Mexico	21	50	2.38
Oregon	76	339	4.46
Utah	24	76	1.88
Washington	76	216	2.84
Wyoming	60	154	2.57
TOTAL	597	1,747	2.99

Table 2

Code values used for discrete variables

Aspect

0 = SE NW
1 = S W
2 = SW
-1 = N E
-2 = NE

Surface texture

1 = coarse skeletal
2 = coarse
3 = coarse loamy
4 = coarse silty
5 = fine loamy
6 = fine silty
7 = fine
8 = very fine

Drainage class

1 = very poorly drained
2 = poorly drained
3 = somewhat poorly drained
4 = moderately poorly drained
5 = well drained
6 = somewhat excessively drained
7 = excessively drained

Irrigation

1 = not irrigated
2 = irrigated

Moisture class

1 = Aridic
2 = Xeric
3 = Ustic
4 = Udic

Moisture status 0 to 20 inches soil

1 = dry throughout
2 = moist in some part
3 = moist throughout
4 = > field capacity

Plant cover

1 = bare soil unshaded
2 = shaded less than 40%
3 = sparse or short grass
4 = shaded 40 to 80% in summer
5 = tall grass
6 = shaded more than 80% in summer, deciduous cover
7 = shaded more than 80% in summer, evergreen cover

variable included in the equation for the last step, then an equation for one of the earlier steps can be used. The data should then be coded for the variables required according to Table 2. If the slope aspect factor ASPF is required, it can be obtained from Figure 1. Care should be used in using Figure 1 to keep track of the sign; if the original aspect is N, NE, or E, then ASPF is always negative; if S, SW, or W, ASPF is always positive; and if SE or NW, then ASPF is always zero.

If MAAT is used, then to predict long-term MAST one should use the long-term normal MAAT. If the MAST is desired for a particular year, then MAAT should be the mean of that particular year. In either case the prediction of MAST should be precise enough for classifying the temperature regime of the soil where measured soil temperatures over a period of five years or more are not available.

Another method of predicting MAST

An even more precise method of predicting MAST from a limited number of soil temperature measurements emerged from the analysis. It was found that the following equation would predict mean annual soil temperature for a given twelve-month period with about equal high precision over the nine western states and probably over a much larger area as well, The equation is:

$$\begin{aligned} AST &= 13.08 + 0.8315\ (\text{mid-April soil temperature at 20 inches}) \\ r &= 0.965 \\ S.E._y &= 1.84 \end{aligned}$$

where AST is the mean soil temperature of the twelve months preceding the April soil temperature measurement.

A similar equation using a mid-October soil temperature measurement is:

$$\begin{aligned} AST &= 7.21 + 0.7906\ (\text{mid-October soil temperature at 20 inches}) \\ r &= 0.944 \\ S.E._y &= 2.17 \end{aligned}$$

Also, if mean air temperature for the twelve months (AAT) preceding the April soil temperature measurement can be obtained from weather bureau data, then the equation for calculating MAST is therefore

$$MAST = 13.08 + (0.8314)(\text{April S.T.}) - 0.944\ (AAT - MAAT)$$

where MAST and MAAT are long-tern means. (The parameter 0.944 is taken from step 1, Table 8.) This procedure provides a very precise way of estimating MAST from a single soil temperature measurement and weather bureau air temperature measurement. Three years of April soil temperature measurements near Escondido gave MAST = 66.4. The equation above calculated MAST to be 66.2.

Table 3

Regression analysis - Pacific Coast States (California. Oregon, Washington)

Step	Equation	r	r^2	Significance level	$S.E._y$
	Including mean annual air temperature				
1	MAST = 1.85 + 1.018 MAAT	0.825	0.680	<0.0001	4.99
2	MAST = 7.64 + 0.980 MAAT - 1.09 PC	0.851	0.724	~0.0001	4.63
3	MAST = 38.98 + 0.765 MAAT - 1.19 PC - 0.475 LAT	0.869	0.756	<0.0001	4.36
4	MAST = 60.11 + 0.541 MAAT 1.01 PC - 0.628 LAT - 0.00138 ELEV	0.892	0.796	<0.0001	3.99
5	MAST = 58.07 + 0.56 MAAT - 0.93 PC - 0.61 LAT - 0.00134 ELEV + 4.82 ASPF	0.934	0.872	<0.0001	2.86
	Excluding mean annual air temperature				
1	MAST = 108.9 - 1.308 LAT	0.681	0.464	<0.0001	6.46
2	MAST = 109.0 - 1.135 LAT - 0.00264 ELEV	0.828	0.685	<0.0001	4.95
3	MAST = 112.4 - 1.144 LAT - 0.00236 ELEV - 1.08 PC	0.852	0.727	<0.0001	4.61
4	MAST = 115.0 - 1.093 LAT - 0.00232 ELEV - 0.97 PC - 2.07 SM	0.859	0.738	<0.0001	4.52
5	MAST = 115.1 - 1.092 LAT - 0.00232 ELEV - 0.90 PC - 2.19 SM + 4.11 ASPF	0.899	0.807	0.0021	2.99

Table 4

Regression analysis - Oregon and Washington

Step	Equation	r	r^2	Significance level	$S.E._y$
Including mean annual air temperature					
1	MST = 8.03 + 0.878 MAAT	0.668	0.447	<0.0001	3.23
2	MAST = 19.41 + 0.713 MAAT - 1.04 SM	0.783	0.614	<0.0001	2.70
3	MAST = 19.26 + 0.712 MAAT - 0.96 SM + 3.48 ASPF	0.798	0.636	0.0016	2.62
4	MAST = 25.34 + 0.62, MAAT - 0.95 SM + 3.80 ASPF 0.000632 ELE"	0.812	0.660	0.0010	2.53
5	MAST = 28.14 + 0.552 MAAT - 0.63 SM + 3.19 ASPF - 0.00075 ELEV- 1.53 OHOR	0.840	0.706	0.0008	2.35
Excluding mean annual air temperature					
1	MAST = 50.06 - 4.03 OHOR	0.588	0.346	<0.0001	3.52
2	MAST = 54.2 - 4.01 OHOR - 0.00142 ELEV	0.705	0.498	~0.0001	3.08
3	MAST = 55.95 - 2.73 OHOR - 0.00132 ELEV - 0.68 PC	0.733	0.539	0.0003	2.95
4	MAST = 78.51 - 2.70 OHOR - 0.00181 ELEV - 0.64 PC - 0.464 LAT	0.752	0.567	0.0014	2.86
5	MAST = 105.35 2.20 OHOR - 0.00213 ELE" - 0.55 PC - 0.863 LAT - 3.10 SM	0.820	0.672	~0.000,	2.49

Table 5

Regression analysis - Colorado and New Mexico

Step	Equation	r	r^2	Significance level	$S.E._y$
Including mean annual air temperature					
1	MAST = 14.73 + 0.741 MAAT	0.759	0.577	<0.0001	3.44
2	MAST = 39.15 + 0.453 MAAT 0.00159 ELE"			<0.0001	
3	MAST = 41.00 + 0.437 MAAT 0.00143 ELE" 0.62 PC			0.0055	
4	MAST = 41.50 + 0.452 MAAT 0.0014 ELEV - 0.62 PC - 0.30 TEXT			0.0058	
5	MAST = -1.89 + 0.452 MAAT - 0.00149 ELE" - 0.62 PC 0.36 TEXT + 0.420 LONG	0.873	0.763	0.043	2.65
Excluding mean annual air temperature					
1	MAST = 68.04 - 0.00272 ELE"	0.762	0.582	<0.0001	3.13
2	MAST = 69.08 - 0.00247 ELE" - 0.76 PC			0.0034	
3	MAST = 69.11 - 0.00241 ELL" 0.764 PC 0.00986 LAT	0.843	0.710	0.0429	2.92

Table 6

Regression analysis - Idaho and Utah

Step	Equation	r	r^2	Significance level	$S.E._y$
Including mean annual air temperature					
1	MAST = 4.02 + 0.942 MAAT	0.802	0.644	<0.0001	3.15
2	MST = 9.39 + 0.831 MAAT - 0.706 PC	0.858	0.736	<0.0001	2.71
3	MAST = 9.40 + 0.879 MAAT - 0.663 PC + 2.29 ASPF	0.862	0.744	0.068	2.67
Excluding mean annual air temperature					
1	MAST = 52.31 - 0.989 PC	0.426	0.181	<0.0001	4.78
2	MAST = 44.86 - 1.01 PC + 7.11 IRR	0.523	0.274	0.0009	4.50
3	MAST = 50.23 - I." PC + 10.2 IRR - 2.22 TEXT	0.637	0.406	~0.0001	4.07
4	MAST = 65.26 - 0.91 PC + 9.36 IRR - 2.82 TEXT - 0.282 LAT	0.699	0.458	0.0003	3.78
5	MAST = 56.74 - 0.51 PC + 5.2 5 IRR - 2.62 TEXT - 0.966 LAT + C.353 LONG	0.79,	0.625	co.0001	3.21

Table 7

Regression analysis - Montana and Wyoming

Step	Equation	r	r^2	Significance level	S.E.y
Including mean annual air temperature					
1	MAST = 13.28 + 0.807 MAAT	0.785	0.616	<0.0001	2.80
2	MAST = 22.20 + 0.718 MAAT - 2.61 SM	0.831	0.690	0.0001	2.52
3	MAST = 22.49 + 0.710 MAAT - 2.51 SM - 2.66 OHOR	0.848	0.720	0.0031	2.39
4	MAST = 15.36 + 0.763 MAAT - 2.56 SM - 2.56 OHOR + 0.97 DRAIN	0.856	0.732	0.038	2.34
5	MAST = -7.47 + 0.792 MAAT - 2.61 SM - 2.46 OHOR + 1.03 DRAIN + 0.198 LONG	0.873	0.762	0.075	2.19
Excluding mean annual air temperature					
1	MAST = 57.25 - 4.70 SM	0.507	0.257	<0.0001	3.90
2	MAST = 62.52 - 5.24 SM - 0.000820 ELEV	0.589	0.347	0.0016	3.65
3	MAST = 172.2 - 2.5 SM - 0.00306 ELEV - 2.345 LAT	0.783	0.613	<0.0001	2.81
4	MAST = 172.0 - 2.86 SM - 0.00291 ECEV - 2.410 LAT + 0.646 TEXT			0.025	2.44

Table 8

Regression analysis - nine western states combined, including mean annual air temperature

Step	Equation	r	r^2	Significance level	S.E.y
1	MAST = 5.74 + 0.944 MAAT	0.873	0.762	<0.0001	3.66
2	MAST = 10.99 + 0.903 MAAT - 0.92 PC	0.897	0.895	~0.0001	3.35
3	MAST = 10.35 + 0.910 MAAT - 0.82 PC + 5.47 ASPF	0.906	0.822	<0.0001	3.20
4	MAST = 6.76 + 0.915 MAAT - 0.80 PC + 5.54 ASPF + 0.66 DRAIN	0.909	0.827	<0.0001	3.16
5	MAST = 9.46 + 0.874 MAAT - 0.79 PC + 5.56 ASPF + 0.72 DRAIN - 0.00241 ELEV	0.911	0.830	0.0004	3.12

LIST OF FIGURES AND TABLES

STATISTICAL PROCEDURE

In preparation for multiple regression analysis, the variables were averaged over the years of record for each station in order to give equal weight to each site, even though the resulting means varied in precision between sites. The average number of years of record was 2.99 years per site. Mean annual values were obtained by averaging values for January, April, July, and October. The data matrix of means per site was subjected to step-wise multiple regression using the CDC-6400 computer at Berkeley[1/] both as a whole and in sections subdivided by groups of states. Because there were considerable missing data scattered through the matrix, the results sometimes were not satisfactory, so the analysis was also performed on data in which missing data were replaced by the mean value of that variable. However, a test of the regression was made by calculating predicted mean soil temperature from the equation derived by the last step of the regression analysis and comparing it with measured values for those sites where there were no missing data. The sets of equations reported in Tables 3 through 8 are those which gave the most accurate predictions on the nonmissing data. The data for the last step in these tables are based upon the test and thus are highly precise. The data given for the first step are also highly precise as simple regression is quite accurate in spite of missing data. The data for intermediate steps are somewhat less accurate.

In order to provide a measure of the slope-aspect factor, the following calculation was used:

$$ASPF = \text{aspect } (\tan^{-1} \text{slope}/100)$$

where slope is in percent and $\tan^{-1}$ is the angle in radians whose tangent is the slope and aspect is the aspect code from Figure 1.

RESULTS AN0 DISCUSSION

The results of the step-wise multiple regression analyses are given in Tables 3 through 8 in which the following abbreviations or code names for the variables are used:

MAST	Mean annual soil temperature - °F
MAAT	Mean annual air temperature °F
ELE"	Elevation - feet
LAT	Latitude - decimal degrees
LONG	Longitude - decimal degrees
ASPF	Tan slope/100 times aspect code
TEXT	Texture code
OHOR	Thickness of 0 horizon in inches
DRAIN	Drainage class code
IRR	Irrigated or not irrigated
PC	Plant cover code
SM	Average soil moisture status code

At each step in these analyses a variable is added. The column headed "Significance level" indicates the probability that adding the variable does not improve the accuracy of prediction of MAST; generally, if the significance level is greater than 0.05, no further steps are recorded. Also, a maximum of five steps is recorded for two reasons. First, equations containing more than five variables are cumbersome; and, second, the analyses showed that the partial correlation coefficient of the sixth variable was always less than 0.20 and, therefore, probably of no great value in predicting MAST.

Also shown arc the values of "r," the multiple correlation coefficient, and "r^2," the coefficient of determination. However, the most useful statistic is the standard error of prediction, $S.E._y$, which is a measure of the accuracy with which the equation predicts MAST. Where MAAT is included, $S.E._y$ is always less than 3.0, except for the "shotgun" run of all nine western states combined, Where MAAT is excluded, only the analysis of Idaho-Utah data gave $S.E._y$ 9reater than 3.0 (3.21). Table 6. In light of the fact that some of the data for MAAT were recorded as the long-term normal temperature for that month rather than the mean for that month in that particular year, it seems probable that the equations including MAAT are actually considerably more precise than indicated by the values of $S.E._y$ for the purpose of predicting long-term mean annual soil temperature (MAST).

Using the equations to predict mean annual soil temperature

For a given State, select the table for which $S.E._y$ in the last step recorded is minimum. Usually, this is the table which includes MAT. If there is an appropriate weather station nearby at nearly the same elevation, then the table including MAAT can be used. If not, then the table excluding MAAT should be employed. If the site data for the particular location in question are complete. then the last step in the table should give the best prediction of MAST. If site data are missing for any

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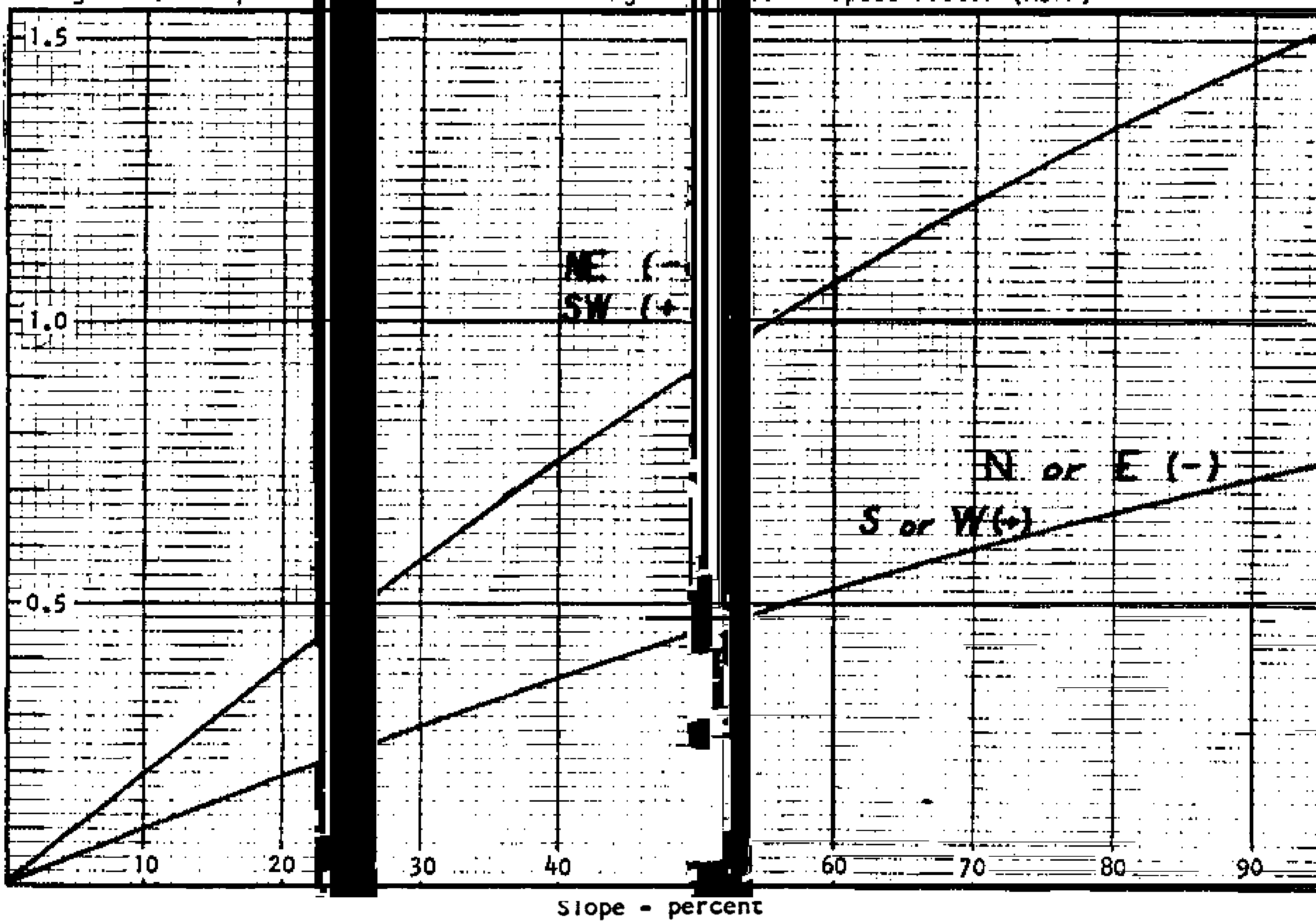
1/The statistical procedure was G2 GC REGRESS of the Ariel Library, which is an adaptation of the IBM 7094 STATPAK program.

Figure 1. Graphica utlon for obtaining the e - aspect factor (ASPF)



NOTES ON COMMITTEE 4

by E. M. Richlen

Discussion:

G.H. Simonson - Should additional data be collected and should data already collected not used in this analysis now be analyzed?

Dick Huff - Indicated Rod Arkley thought we could quit collecting data as "elevation is the most important factor."

Bud Giese - Easy to predict soil temperature in Hawaii if you know the elevation.

K. W. Flach - Using computer, air temperature and other data it's easy to predict soil temperature.

Conference Participants - Accepted the report and voted to continue Committee 4

Committee 4:
R. J. Arkley, Chairman
A. J. Cline
*R. C. Kronenberger
*C. A. Lowitz
*E. M. Richlen
*J. A. Williams

*Present at conference

ENVIRONMENTAL SOIL SCIENCE

Committee 5

The following charges were given to the committee:

1) Prepare a literature review on information as to how degradation rates of pesticides and herbicides may be affected by the various soil properties that are used to define soils in the National Cooperative Soil Survey.

2) Prepare an inventory of research work involving environmental quality being conducted at each institution within the region and summarize those activities that are related to pedology.

3) Prepare preliminary guidelines for rating soil properties that influence soil behavior in organic waste breakdown.

4) Prepare an inventory of research in hydrology and propose how this work can be integrated with soil survey activities.

The committee agreed that charge 1 was not particularly suitable for committee action. Besides, the Agricultural Research Service (ARS) is presently preparing a comprehensive pesticide report that includes the subject matter of this charge. Matters pertaining to soil survey in this report should be summarized after it has been published. Parts of the manuscript of the report have been available to the committee, however, and will be mentioned in part 2 of this report. The committee also felt that charge 3 is too ambiguous for committee action. The system by which the organic waste is added has to be defined. One member of the committee has been a member of a Western Regional Ad hoc committee that prepared an outline for a Western Regional Cooperative Research Project on "Soil as a Waste Treatment System." One of the objectives of the proposed Regional Cooperative Research Project is "to devise guidelines for identifying and inventorying recognized taxonomic soil units that are most effective for various types of waste management systems." A short discussion of the objectives of the Cooperative Research Project is included in part 2 of this paper.

In view of these developments the committee decided to concentrate on charges 2 and 4. This task was performed by members of the committee and in part by State Soil Scientists in cooperation with the Soil Survey representatives of the Agricultural Experiment Stations. An indexed listing of research projects related to environmental quality and soil hydrology has been prepared. As this listing is too voluminous to be made part of this report only three copies have been prepared. One of these copies will be submitted to the appropriate committee of the National Work Planning Conference. The other two copies are on file at the office of the Principal Correlator, WNTSC and at the Riverside Soil Survey Laboratory. Replies reporting 211 different research activities were received. The replies, however, varied greatly in the comprehensiveness of coverage and in the detail with which individual projects were discussed. In some states some institutions are treated in much greater detail than other ones. The inventory can therefore only be considered a first step and it will be amended and updated in the future.

II. Other considerations:

In the last few years a great many bibliographies, review papers, proceedings symposia, and books on the relationship of agriculture and soils to the quality of the environment have appeared. They include the following:

1965. Restoring the quality of our environment. President's Science Advisory Committee, Environmental Pollution Panel.

1968. Wastes in relation to agriculture and forestry. Misc. publication No. 1065, U. S. Department of Agriculture.

1969. Cleaning our environment, the chemical basis for action. American Chemical Society, Subcommittee on environmental improvement.

1970. Pesticides in the soil: Ecology, degradation, and movement. International Symposium on pesticides in the soil, Michigan State University.

1970. Agricultural practices and water quality. From a conference on "The Role of Agriculture in Clean Water," Iowa State University Press.

1970. Fertilizer use and water quality. By G. Stanford, C. B. England, and A. W. Taylor, ARS 41-168, USDA.

1971. Environmental thrust handbook, United States Department of Agriculture.

19[illegible]. Agricultural benefits and environmental changes resulting from the use of digested sewage sludge on field crops. An interim report, U. S. Environmental Protection Agency.

1971. Workshop for pollution abatement through soil and water management. Portland, 1971, Soil Conservation Service.

1971. A primer on agricultural pollution. By Cecil Wadleigh, Soil Conservation Society of America.

[redacted] identification is restricted to a mention of the series name or a broad statement of textural class. Almost no efforts have been made to study systematically the interaction of pollutants or pollutant disposal systems with defined ranges in soil properties. Nevertheless a few general deductions can be made and a few specific research needs can be identified.

1) Pesticides

a) Herbicides. The efficacy and persistence of non-ionic herbicides is related to their vapor pressure. Vapor pressure, in turn, is in part related to inherent properties of the herbicides and to the strength with which the herbicide is adsorbed by the soil. Most herbicides are nonpolar organic compounds and are not water soluble. Their adsorption seems to be controlled primarily by the moisture content and the organic matter content of the soil. Adsorption is much higher, by several orders of magnitude, by soils that lack a monomolecular layer of water. This condition is only reached by dry surface soils or air-dry samples in the laboratory. Hence very high values for adsorption measured on air-dry laboratory specimens may be misleading. Herbicide absorption increases with organic matter content, the relative increase being about the same for dry or moist specimen. Studies conducted so far have shown no consistent effects from other soil properties. This may be due, however, to the fact that most studies have included only a limited range of soil conditions. Vapor pressure and hence volatilization of herbicides from soils is also strongly dependent on temperature. Soil color, exposure, and plant cover may therefore strongly influence the persistence of herbicides in soils. A few herbicides are ionic and water soluble. Some (e.g. picloram) are non-ionic in a neutral environment and become ionic under conditions of acidity that are within the range encountered in soils. A special problem is posed by the disposal of herbicide containers. Burning is now prohibited in many areas. The California State Department of Public Health, for example, estimates that 3.9 million agricultural pesticide containers were used in 1969 in California alone. To protect water quality, containers must be disposed of only in land [redacted] Since few people will drive a hundred miles to dispose of empty barrels these laws are obviously being violated.

Research needs: It should be possible to make recommendations for rates and frequencies of herbicide applications that take into account the differences in the effectiveness and persistence of herbicides on various soils. This would allow lowering application rates and would minimize the pollution hazard. Herbicides volatilize and may be washed out from the air and moved to bodies of water by subsequent rains. Or they may be adsorbed on soil particles and moved in suspension. The latter is probably the more important mechanism for polluting waters. Hence, herbicides should not be used on soils that may be subject to erosion soon after application. We should develop guidelines for rates and timing of herbicide application for groups of soils. Separate recommendations for various aspects may have to be made for the steeper slope phases. We should also develop guidelines that may assist in making preliminary selections of disposal sites for herbicide containers. Such selections should, of course, be followed by detailed on-site investigations. Special, and possibly more restrictive, recommendations may have to be developed for potentially water-soluble herbicides such as picloram.

b) Insecticides. Most insecticides behave in soils similar to herbicides but most insecticides are not applied to the soil directly. A considerable part of the applied insecticides may, however, end up in the soil and remain there for considerable periods of time, or volatilize, or undergo chemical changes and then volatilize. DDT, for example, may change to DDD and DDE. The evidence available so far indicates that these alteration products are as undesirable ecologically as the parent product. Conceivably, guidelines for the safe application of insecticides should take into account differences in adsorption capacity of soils as well as slope and erodibility.

2) Nitrogen

Recently, there has been much attention given to nitrogen in the environment. Any nitrogen applied to the soil or released from the soil through the oxidation of organic matter may be converted to nitrates and nitrites. Nitrites are very toxic to plants and animals. Nitrates in high concentrations in drinking water may cause methemoglobinemia of infants and high nitrate content of forages may cause nitrate toxicity (especially with ruminants). Ensilage high in nitrates may form toxic "silo gases." Nitrates, like other plant nutrients, may also contribute to the eutrophication of rivers and lakes. There have been numerous reviews on nitrate in soils, but again, these reviews have paid only scant attention to differences among various soils. Nitrate is not, or only negligibly, adsorbed by most soils and its movement through the soil to bodies of water is either on the surface by runoff, or through the soil profile. Hence, the infiltration capacity and the hydrology of the soil profile largely control the fate of applied nitrates. Under mildly reducing conditions and in the presence of an energy source (organic matter) nitrate may be reduced to nitrogen gas that escapes to the atmosphere. This aspect of the nitrogen cycle is very closely related to soil morphology. Unfortunately it is only poorly understood and it does not lend itself readily to simple laboratory experiments. At pH 7 nitrate is reduced in soils at a redox potential of about +225 mv. This potential is considerably above that at which manganese and iron are reduced. Hence, nitrate may be reduced readily in soils that appear well drained by our present criteria. Present evidence indicates that after nitrate is leached from the soil profile it will be stable in the underlying geologic column. The optimal timing of N fertilization may differ among soils and slope (and other) phases of soils. Whether N is likely to be leached or reduced, and whether the soil is warm enough for nitrification or denitrification to occur are important considerations.

Research needs:

1. We should pay more attention to nitrate pollution aspects in suitability ratings for septic tanks and lagoons.

2. We should establish denitrification potential classes for soils and, conceivably, use these classes in conjunction with septic tank suitability classes. Gordon Huntington of the University of California has used denitrification potential classes in the evaluation of the upper basin of the Santa Ana River in California. His classes and criteria are as follows:

   1. Low — Little or no denitrification can be expected under natural conditions. Difficult to artificially induce the process.

   2. Moderate — Seasonal or periodic zones of denitrification within the soil mass can be expected. Moderate effort required to induce extensive denitrification within the soil.

   3. High — Denitrification processes normally occur unless soil artificially drained. Processes are extensive through the soil at a depth where all components necessary for denitrification coincide. If necessary, denitrification processes easily induced.

   Optimum soil and management requirements for denitrification may, however, conflict with requirements for salinity control in areas where this is a problem. Denitrification potential classes may also be useful in establishing guidelines for timing of application of nitrogen fertilizers in humid areas.

3. We should explore the possibility of establishing maximum safe rates and safe periods for various forms of N application for phases of taxa.

3) Phosphorus

Phosphorus in fertilizers has been blamed for eutrophication. It has been shown, however, that the major contribution of phosphorus to our water supplies is through municipal and industrial wastes. The removal of phosphates from such wastes using suitable soils as sinks may become an important use of soils. Like pesticides, phosphates are firmly bound to soil particles under most conditions. Hence erosion control is the major item in preventing movement of fertilizer phosphates from soils to bodies of water.

Research needs:

Differing phosphate fixation capacities of soils may be considered in recommending soils for sewage disposal systems.

4) Municipal and industrial wastes

These wastes consist of solid wastes, liquid wastes, or solids suspended in a liquid medium. Soil interpretations for solid waste disposal in sanitary landfills have been developed. Possibly more attention to ground water pollution from nitrates and soluble salts should be given. The disposal of liquid municipal and industrial wastes has been much discussed recently, traditional means of dumping wastes into waterways and the ocean having been declared undesirable. A number of schemes for using liquid municipal wastes for irrigation, and for filtering through the soil and ground water recharge, have been developed. Some of these systems, particularly in Europe, have been operating for long times. A system for disposing the liquid wastes of Muskegon County, Michigan is under construction. This system includes an irrigation area of 6,000 acres using center pivot irrigation systems. Larger systems for cities such as Chicago, Los Angeles, and Portland, Oregon are being discussed. So far, soil scientists have not been much involved in the planning of these systems. The permeability, ability to absorb toxic heavy elements, ability to remove nitrates and ability to tolerate the salt load are important soil properties to be considered. The composition of the liquid wastes must also be taken into account. Land disposal systems in operation now use primarily domestic sewage. Municipal sewage from cities with appreciable industries may contain significant amounts of toxic material, particularly heavy elements.

Sewage wastes rapidly form an impermeable crust on the disposal areas. If these crusts are, however, allowed to dry they break up and there does not seem to be a long-term reduction of infiltration rates. Soils of very low permeability have also been used for liquid waste disposal systems at least of cannery wastes. In this case the wastes are added to vegetated and terraced, gently sloping areas and the runoff is collected. Systems in operation remove almost all the nitrogen and phosphorus in the waste.

As mentioned before, a "Western Regional Cooperative Research Project" on "Soil as a waste treatment system" has been established. The objectives of this project are as follows:

1) To determine the effect of waste components on the chemical, physical and biological characteristics of soils.

2) To characterize soils in relation to their "waste treatment capabilities" and determine soil parameters of most significance in the retention, fixation and transformation of waste components consistent with meeting quality standards of water and air effluents.

3) To devise guidelines for identifying and inventorying recognized taxonomic soil units most effective for various types of waste and management systems.

As indicated by these objectives, this project differs from other research projects on "environmental pedology" in emphasizing soil taxa. The project provides that benchmark or well-characterized soils representative of large areas within the region will be selected. These soils will be correlated and pertinent physical, chemical and mineralogical characteristics will be determined. The outline further provides that a three-dimensional description of the study area (which would include a detailed soil map) will be recorded to include such items as type and quality of vegetation, and the slope and pedologic uniformity of the area. The Soil Survey Laboratories and the Soil Correlation staff are named as cooperators in the project.

Research needs:

1. Develop guidelines for the identification of soils that may be used in liquid waste disposal systems. The guidelines should allow for various types of loading systems and loading rates, consider various types of wastes, and nitrogen and salt loads. Existing systems that have been operating for significant periods of time should be studied concerning their effect on soil properties.

5) Feed lots and dairy wastes

Recent changes in the organization and size of beef feeding and dairy farm operation have brought about a serious disposal problem. The Agricultural Research Service and the Agricultural Experiment Stations are conducting several intensive studies of the problem, primarily in the states Nebraska, Colorado, and the high plains of Texas. In some cases wastes are collected in lagoons. Criteria for the suitability of soils for lagoons have been developed. Present criteria include the requirement that the soil can be made impermeable. Some research has indicated, however, that feed lot wastes seal the bottoms of lagoons rapidly even if constructed on relatively permeable soil materials. In some areas the manure is disposed on land. Maximum safe loading rates and erosion standards have to be established. A similar seal that prevents downward movement of water and encourages reducing conditions that cause denitrification is found under feed lots. Feed lots should be managed so that this seal is not destroyed when manure is removed.

Research needs:

We should establish more appropriate criteria for the suitability of soils for lagoons and establish realistic loading rates for manure disposal on land.

III. Recommendations:

The committee makes the following recommendations:

1) The National Cooperative Soil Survey should cooperate with agencies conducting research on matters of environmental concern. Soil taxonomists should encourage research designs that include soils that are representative and have a large range of properties so that the results of research can be extrapolated to a large variety of soils in a large variety of environmental conditions. Soil taxonomists should join committees that are planning and coordinating research in matters of environmental concern from a state, regional, or national basis. Plots used in field experiments should be mapped and classified in detail. Soils used in experiments should be characterized by standard soil survey procedures.

2) The inventory of research projects in environmental pedology should be continued.

3) The National Cooperative Soil Survey should encourage and participate in the development of a program for monitoring soil changes in existing liquid waste disposal systems.

4) The National Cooperative Soil Survey should consider the feasibility of developing guidelines for the safe application of pesticides on individual soils.

5) The National Cooperative Soil Survey should develop criteria for evaluating soils and wastes for their suitability for a soil based liquid waste disposal system.

6) The National Cooperative Soil Survey should develop criteria for placing soils into denitrification potential classes.

7) In cooperation with other agencies the National Cooperative Soil Survey should develop guidelines for the timing and rates of nitrogen fertilizer application for various soils that would minimize damage to the environment.

8) The committee recommends that it be continued.

Committee members:

[illegible]	[illegible]
Thomas Collins	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible], Chairman

UNITED STATES DEPARTMENT OF AGRICULTURE:
Soil Conservation Service
1972 Western Regional Technical Work Planning Conference
of the Cooperative Soil Survey
January 22-28, 1972, Hilo & Honolulu, Hawaii
Committee 6-Engineering Application and Interpretation of Soil Surveys

The charges given to the committee are as follows:

Charge 1. Submit to the conference for approval the guidebook to engineering interpretations of soils for specialists in other disciplines.

Charge 2. Test and review the guides for interpreting engineering uses of soils and propose revisions as needed.

Charge 3. Propose ways of interpreting allowable soil pressure:: and how to express it in such a way that planners and builders can make use of the predictions.

Response to charges is as follows:

Charge 1. The guidebook follows.

Conference discussion on the guidebook:

1. Page 11 - It was suggested that moist consistence be determined at plastic limit.
2. Conference felt that the title should be changed to "Guidebook for Users of the Soil Survey".
3. Question: Should first 22 pages of back-up material be left in? The vote was 11 to 9 to leave these pages in the guidebook.
4. Question: Should interpretation criteria be in this guide? The vote was 23 to 2 to leave criteria a 8276 0.8379.1200073 0

Committee Members:

A. R. Hidlebaugh, Chairman
3. U. Anderson
K. E. Bradshaw
L. A. Bronaugh
J. F. Corliss
R. Fox
R. Heil

H. A. Homan
M. S. James
L. N. Langan
C. A. Lowitz
L. Lund
E. A. Naphan
G. Nielson

W. D. Nettleton
G. Simonson
J. Stevenson
W. A. Wertz
J. A. Williams

GUIDEBOOK FOR SOIL SURVEYS

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GUIDEBOOK FOR SOIL SURVEYS

I. FORWARD

This guidebook is intended to help users understand and use the interpretations of soils in the National Cooperative Soil Survey. It is written for specialists in disciplines other than soil science. These include, but are not limited to, engineers, planners, sanitarians, real estate agents, developers, contractors, conservationists, and bankers.

The soil scientist, the engineer and others use different terms to define some soil properties, qualities, and interpretations. This is confusing to the user of the soil survey. This guidebook points out where differences in terminology exist and gives the terminology of the soil scientist.

#

This guidebook is in response to Charge 1 given to Committee 6- Engineering Applications and Interpretations of Soil Surveys of the Western Regional Technical Work Planning Conference for Soil Survey, Honolulu, Hawaii, January 22-29, 1972.

Al Hidlebaugh, Chairman
Committee 6

II. SOILS, THEIR NATURE AND ORIGIN

A. Soil

1. Definition of soil   Soil has many meanings. It is subject to a difference of opinion, depending on who is defining it. The engineer considers soil as virtually every type of uncemented or partially cemented inorganic and organic material overlying bedrock. The geologist considers soil as the unconsolidated material overlying bedrock. To the mining engineer soil is the debris that covers the rocks or minerals he wants to mine. To the agronomist and most laymen, soil is that thin layer of the earth's crust containing organic matter and supporting plant and animal life. The soil scientist considers soil as a natural, dynamic body that has both depth and surface area.

   The definition of soil used throughout this guidebook is as follows: Soil is a dynamic three-dimensional natural body. It's upper surface is the surface of the land; its lower boundary is parent material or rock; and it is bounded on its sides by other soils, exposed bedrock, or water. The characteristics of any given soil are the result of the combined effects of climate and living matter acting on parent material, as conditioned by topography over different periods of time.

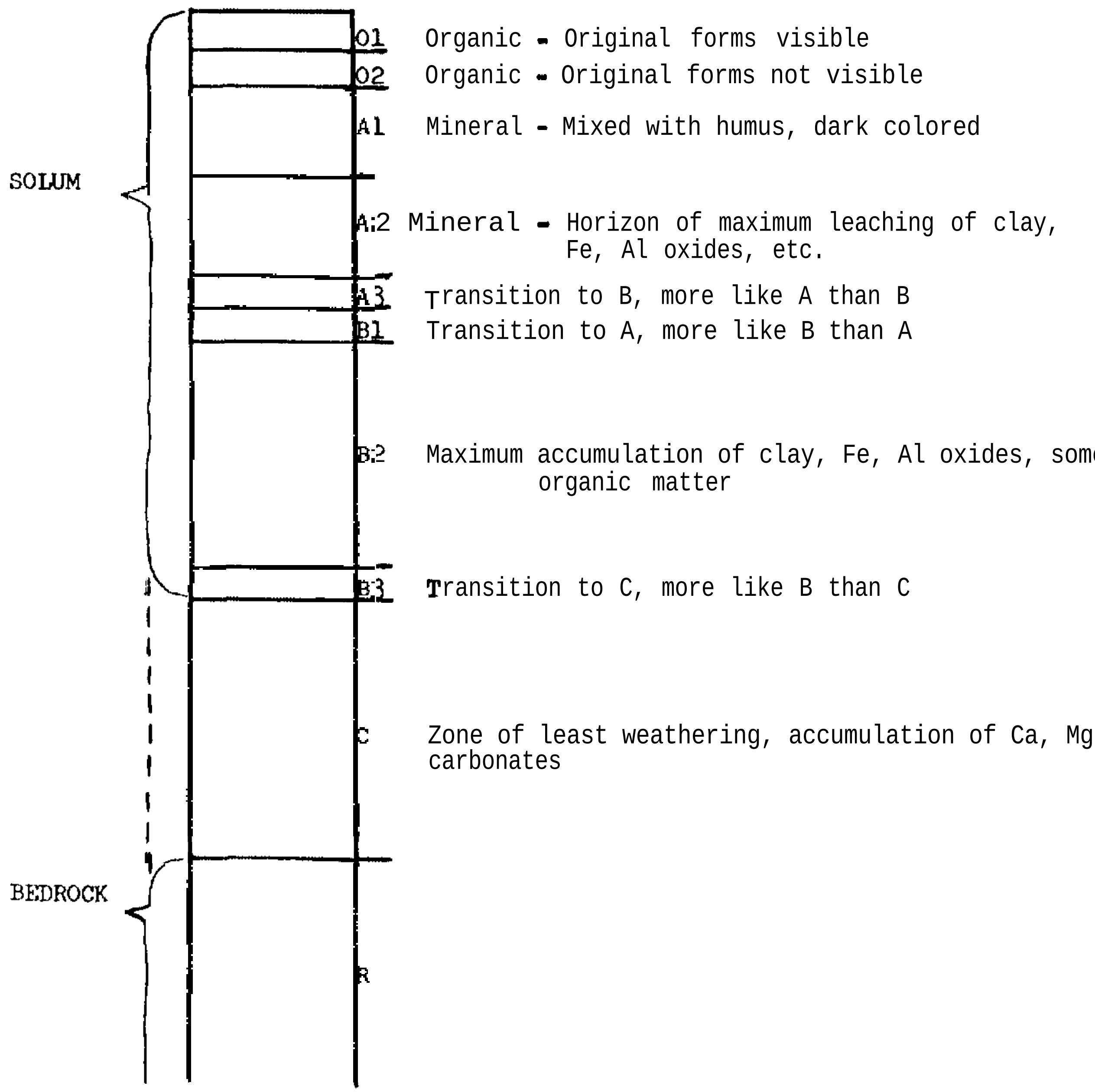
   One of the major differences in definition between the engineer and the soil scientist should be emphasized. This is the concept of the engineer that slope and natural drainage are site factors apart from the soil, because these are things the engineer can alter during construction. The soil scientist considers slope and natural drainage as a pert of a soil.

   Soils vary greatly from place to place, often within short distances, depending on the interactions of the soil forming factors. These changes give rise to different kinds of soil profiles and different horizons within a given soil profile.

2. Profile   Every soil has a profile--a combination of layers in a vertical cross section. The soil profile consists of two or more layers lying one below the other and more or less parallel to the surface of the earth. These layers are called soil horizons. Soil horizons differ from each other in one or more properties such as color, texture, structure, consistence, porosity, content of rock fragments, and reaction. Figure 1 is a hypothetical soil profile showing all the horizons that are recognized by soil scientists.

   In this guidebook the horizons in a soil profile are grouped into three major horizons--the A, B, and C horizons. The A and B horizons have been formed by weathering and soil forming processes and are referred to as the solum of the soil. The C horizon has undergone very little weathering. The A horizon is commonly referred to as the surface layer, the B horizon as the subsoil, and the C horizon as the substratum. Some profiles have R horizons which are bedrock.

Figure 1. A hypothetical soil profile having all the soil horizons



B. Properties and Qualities

1. Color Color is the most obvious and easily determined of soil characteristics. Although it has little direct influence on the functioning of the soil, one may infer a great deal about a soil from its color, if it is considered with the other observable features. Thus the significance of soil color is almost entirely an indirect measure of other more important characteristics or qualities that are not so easily and accurately observed. Color is one of the most useful and important characteristics for soil identification.

   Dark surface layers generally indicate high organic matter content, while light-colored surface layers generally indicate low organic matter content. The subsoil color is an indication of the natural drainage of a soil and of the presence or absence of a seasonal high water table. Solid brownish, reddish or yellowish colors generally indicate well drained conditions with seasonal water table below the solum. Solid gray colored subsoils or mixed gray with brown, yellow, or red colors indicate restricted drainage and the presence of a seasonal high water table.

2. Texture

   a. Soil particle sizes Most soils are composed of particles varying greatly in size and shape. In the U.S. Department of Agriculture system soil grains are divided into three major size groups. These are clay, silt and sand. Clay (less than 0.002 millimeters in diameter) particles are microscopic in size and generally plastic and sticky when moist. When most clays in the United States are wetted with water, they expand or swell; and on drying they shrink. Silt (0.05-0.002 millimeters in diameter) particles are also microscopic, for the most part, and have many of the same properties as clay. Silt, however, is not generally as plastic as clay, nor does it shrink and swell on wetting and drying as much as clay. Sand (2.0-0.05 millimeters in diameter) particles are visible to the naked eye. Sand exhibits very little or no plasticity or stickiness. Soils dominated by sand generally have low available water capacity and generally have rapid permeability.

   b. Texture classes Rarely, if ever, do soil samples or soil horizons consist wholly of one soil separate or size group of soil grains. Classes of soil texture are based on different combinations of sand, silt, and clay. The amount of each soil separate contained in a soil sample determines its texture or feel. Chart 1 lists the broad textural classes and basic soil texture classes and the composition of each textural class in terms of sand, silt, and clay. It will be noted from this table that the proportion of various size soil particles determines the name of the textural class. The presence of coarse particles larger than very coarse sand and smaller than 10 inches is recognized by modifiers

CHART 1 SOIL TEXTURAL CLASS NAMES AND APPROXIMATE PERCENT OF SAND, SILT & CLAY.

GENERAL TERMS	BASIC SOIL TEXTURAL CLASSES	COMPOSITION		
		SAND PERCENT	SILT ERCENT	
Coarse	SANDS[1] Coarse sand Sand Fine sand Very fine sand	+85	-15	
Textured Soils	LOAMY SANDS[1] Loamy coarse sand Loamy sand Loamy fine sand Loamy very fine sand	70-90	-30	
Moderately Coarse Textured Soils	SANDY LOAMS[1] Coarse sandy loam Sandy loam Fine sandy loam Very fine sandy loam	43-85	-50	-20
Medium Textured Soils	LOAM SILT LOAM SILT or	23-52 20-50	28-50	7-27
Moderate Fine-textured Soils	CLAY LOAM SANDY CLAY LOAM SILTY CLAY LOAM	20-45 45-80 -20		
Fine-textured Soils	SANDY CLAY SILTY CLAY CLAY	45-65 -20 -45	-20 40-60 -40	35-55 40-60 +40

+ = more than
- = less than

of the textural class names, like cobbly loam or gravelly loam. Classes of still larger particles, stones or boulders, are used as a prefix with the basic texture class, such as stony loam, very stony loam, or bouldery loam.

The basic texture classes in order of increasing proportions of the fine separates, such as silt and clay, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. Classes with the term "sand" are modified with the term very fine, fine, coarse, or very coarse, depending on the dominant size of the sand in the texture class.

c. Field and laboratory identification of soil texture The common field method of determining the class name of a soil is by its feel. As much can be judged about the texture and hence the class name of a soil merely by rubbing it between the thumb and fingers as by any other means other than laboratory analysis. Usually it is helpful to wet the sample to estimate plasticity and stickiness more accurately. The way a wet soil "slicks out" gives a good idea as to the amount of clay present. Sand particles are gritty, whereas silt has a floury or talcum powder-like feel when dry, and is only moderately plastic and sticky when wet. Determining the soil texture in the field requires skill and experience, but good accuracy can be obtained if the field men frequently check against laboratory results or reference samples.

The soil must be well moistened and rubbed between the fingers for proper determination of the textural class by feel. The following guidelines are provided below for the determination of the basic soil texture classes in terms of field experience and feel:

Sand: Individual grains can be seen and felt readily. Squeezed in the hand when dry, this soil will fall apart when the pressure is released. Squeezed when moist, it will form a cast that will hold its shape when the pressure is released but will crumble when touched.

Sandy loam: Consists largely of sand, but has enough silt and clay present to give it a small amount of stability. Individual sand grains can be seen and felt readily. Squeezed in the hand when dry, this soil will fall apart when the pressure is released. Squeezed when moist, it forms a cast that will not only hold its shape when the pressure is released but will withstand careful handling without breaking. The stability of the moist cast differentiates this soil from sand.

Loam: Consists of an even mixture of the different sizes of sand, silt, and clay. It is easily crumbled when dry and has a slightly gritty, yet fairly smooth feel. It is slightly plastic. Squeezed in the hand when dry, it will form a cast that will withstand careful handling. The cast formed on moist soil can be handled freely without breaking,

Silt, loam: Consists of a moderate amount of fine grades of' sand, a small amount of clay, and a large quantity of silt. particles. Lumps, in a dry, undisturbed state, appear quite cloddy hut they can be pulverized readily; the **soil** then feels soft and floury. 'When wet, silt loam runs together and puddles. Either dry or moist, casts can be handled freely without breaking. When a ball of moist soil is pressed between thumb and finger, it will not press out into a smooth unbroken ribbon, but will have a broken appearance.

Clay loam: A fine-textured soil that breaks into clods or lumps, which are hard when dry. When a ball of moist soil is pressed between the thumb and finger, it will form a thin ribbon that will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will withstand considerable handling.

Clay: A fine-textured soil that breaks into very hard clods or lumps when dry, and is plastic and unusually sticky when wet. When a ball of moist soil is pressed between the thumb and finger, it will form a long ribbon.

A more accurate and fundamental method is used by the U. S. Department of Agriculture for the naming of soils based on the mechanical analysis in the laboratory. Chart 2 is a guide for the USDA soil texture when the proportions of sand, silt, and clay have been determined in the laboratory. It also can serve as a guide to the field determination or the interpretation of texture once the textural class name is known,

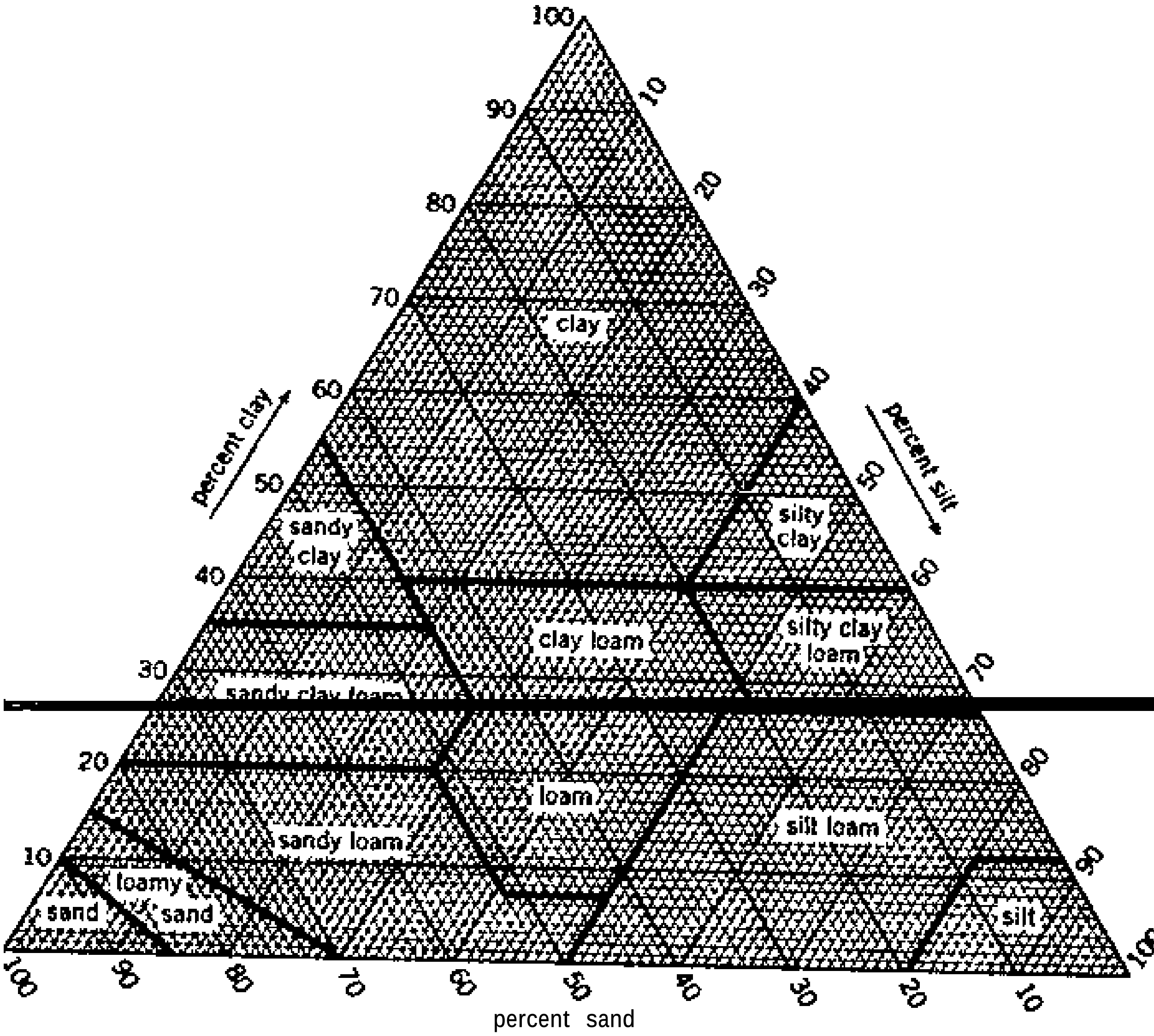
d. Significance of different texture classes The texture of a soil horizon is, perhaps, its most nearly permanent characteristic. Soil structure ran be quickly modified by management. Soil texture then is one of the principle

CHART 2

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

GUIDE FOR TEXTURAL CLASSIFICATION

May 1, 1950



3. <u>structure</u>   The particular type of soil structure present in a soil exerts a great influence on soil qualities and the many potential uses of a soil. Soil structure influences water movement, heat transfer, aeration, bulk density, and porosity.

Soil structure refers to the aggregation of the primary soil particles of silt, sand, and clay into compound particles, or clusters of primary soil particles, which are separated from adjoining aggregates or clusters by surfaces of weakness. Areas of some aggregates have thin, often dark colored, surface films that perhaps helped to keep them apart. The individual natural soil aggregate is called a ped, in contrast to a clod, which is caused by a disturbance such as plowing or digging.

Field descriptions of soil structure by soil scientists give the (1) shape and arrangement, (2) size, and (3) the distinctness and durability of the visible aggregates or peds. Four primary types of structure are classified: (1) platy, with particles arranged around a plane, generally horizontal; (2) prism-like, with particles arranged around a vertical line bounded by relatively flat vertical surfaces; (3) Block-like or polyhedral particles arranged around a point and bounded by flat or rounded surfaces which are cast in molds formed by the faces of surrounding peds; and (4) spheriodal or polyhedral, with particles arranged around a point bounded by curved or very irregular surfaces that are not accommodated to the adjoining aggregates.

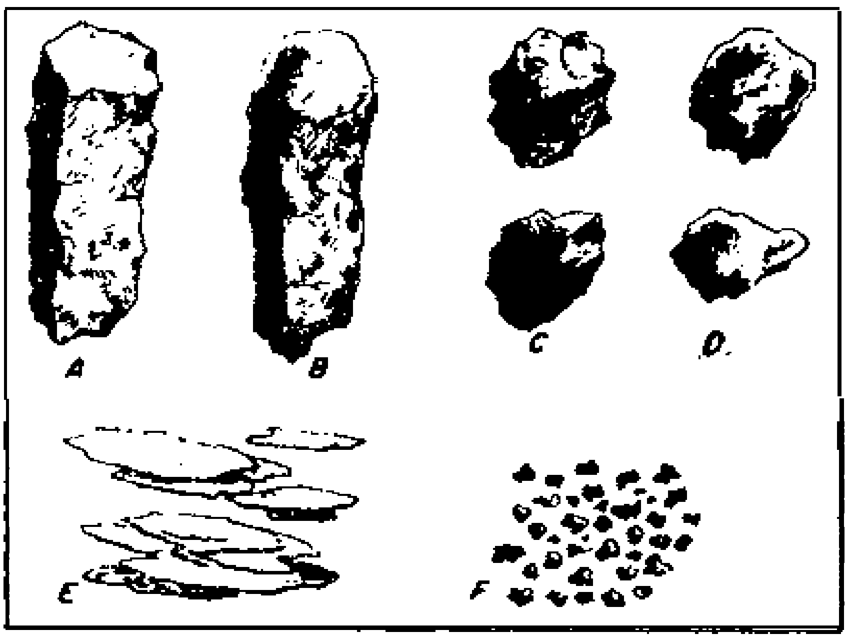
The grade of structure is the degree of aggregation that expresses the difference between cohesion within aggregates and adhesion between aggregates. The grade of structure is usually expressed as: (1) structureless; (2) weak; (3) moderate; and (4) strong.

Chart 3 illustrates the different types of structure commonly found in soils.

Soil structure has a great effect on permeability or percolation rate of soils. In soils with similar texture, the structure determines the rate of water movement. Soils with well developed blocky structure have more rapid percolation rate than soils of similar texture with a platy structure. The size and degree of development of soil aggregates also influences the percolation rate of soil water.

4. <u>Consistence</u>   Soil consistence comprises the characteristics of soil material that are expressed by the degree and kind of cohesion and adhesion or the resistance to deformation or rupture.

Chart 3. Drawings illustrating some of the types of soil structure: A-prismatic; B-columnar; C-angular blocky; D-subangular blocky; E-platy; and F-granular.



The terms used in soil descriptions for consistence follow:

I. CONSISTENCE WHEN WET

Consistence when wet is determined at or slightly above field capacity.

A. Stickiness Stickiness is the quality of adhesion to other objects. For field evaluation of stickiness, soil material is pressed between thumb and finger and its adherence noted. Degrees of stickiness are described as follows:

0. Nonsticky: After release of pressure, practically no soil material adheres to thumb or finger.
1. Slightly sticky: After pressure, soil material adheres to both thumb and finger but comes off one or the other rather cleanly. It is not appreciably stretched when the digits are separated.
2. Sticky: After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than pulling free from either digit.
3. Very sticky: After pressure, soil material adheres strongly to both thumb and forefinger and decidedly stretched when they are separated.

B. Plasticity Plasticity is the ability to change shape continuously under the influence of an applied stress and to retain the impressed shape on removal of the stress. For field determination of plasticity, roll the soil material between thumb and finger and observe whether or not a wire or thin rod of soil can be formed. If helpful to the reader of particular descriptions, state the range of moisture content within which plasticity continues, as plastic when slightly moist or wetter, plastic when moderately moist or wetter, and plastic only when wet, or as plastic within a wide, medium, or narrow range of moisture content. Express degree of resistance to deformation at or slightly above field capacity as follows:

0. Nonplastic: No wire is formable.
1. Slightly plastic: Wire formable but soil mass easily deformable.
2. Plastic: Wire formable and moderate pressure required for deformation of the soil mass.
3. Very plastic: Wire formable and much pressure required for deformation of the soil mass.

II. CONSISTENCE WHEN MOIST

Consistence when moist is determined at a moisture content approximately midway between air dry and field capacity. At this moisture content moat soil materials exhibit a form of consistence characterized by (a) tendency to break into smaller masses rather than into powder, (b) some deformation prior to rupture, (c) absence of brittleness, and (d) ability of the material after disturbance to cohere again when pressed together.

The resistance decreases with moisture content, and accuracy of field descriptions of this consistence is limited by the accuracy of estimating moisture content, To evaluate this consistence, select and attempt to crush in the hand a mass that appears slightly moist.

0. **Loose:** Noncoherent.
1. Very friable: Soil material crushes under very gentle pressure but coheres when pressed together.
2. Friable: Soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.
3. Firm: Soil material crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.
4. Very firm: Soil material crushes under strong pressure; barely crushable between thumb and forefinger.
5. Extremely firm: Soil material crushes only under very strong pressure; cannot be crushed between thumb and forefinger and must be broken apart bit by bit.

The term compact denotes a combination of firm consistence and close packing or arrangement of particles and should be used only in this sense. It can be given degrees by use of "very" and "extremely."

III. CONSISTENCE WHEN DRY

The consistence of soil materials when dry is characterized by rigidity, brittleness, maximum resistance to pressure, more or less tendency to crush to a powder or to fragments with rather sharp edges, and inability of crushed material to cohere again when pressed together. To evaluate, select an air-dry mass and break in the hand.

0. **Loose:** Noncoherent.
1. soft: Soil mass is very weakly coherent and fragile; breaks to powder or individual grains under very slight pressure.
2. Slightly hard: Weakly resistant to pressure; easily broken between thumb and forefinger.
3. Hard: Moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.
4. Very hard: Very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.
5. Extremely hard: Extremely resistant Co pressure; cannot be broken in the hands.

5. Reaction and Effervescence

Soil reaction receives special emphasis in soil classification, partly because of its direct importance but mainly because of other soil qualities, less easily determined, that may be inferred from it. Early field workers distinguished roughly between acid soils and alkaline soils by testing for carbonates with dilute acid and by the use of litmus paper and phenolphthalein. Since then, better field methods, based upon laboratory methods, have become available.

pH

The intensity of soil acidity or alkalinity is expressed in pH--the logarithm of the reciprocal of the H-ion concentration. With this notation, pH 7 is neutral; lower values indicate acidity; and higher values show alkalinity. Soil horizons vary in pH from 8 little below 3.5 to 8 little above 9.5.

The corresponding terms to use for ranges in pH are 8s follows:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 - 5.0
Strongly acid	5.1 - 5.5
Medium acid	5.6 - 6.0
Slightly acid	6.1 - 6.5
Neutral	6.6 - 7.3
Mildly alkaline	7.4 - 7.8
Moderately alkaline	7.9 - 8.4
Strongly alkaline	8.5 - 9.0
Very strongly alkaline	9.1 and higher

Generally, pH reflects the base status of the soil. Acid soils are high in exchangeable hydrogen, and alkaline soils, high in exchangeable bases. The base status of the several horizons, taken with their other characteristics, tells a lot about the kind and degree of weathering, the composition of the parent material, the amount of leaching, and the influence of the vegetation. Since other factors, like the kind of clay, kind and amount of organic matter, the particular exchangeable bases present, and the soluble salts in the soil, influence pH, the relationship between pH and base status is not the same for all kinds of soil.

The presence of free carbonatis in the soil may be tested for with 10 percent hydrochloric acid. The reaction is indicated as slight, strong, or violent effervescence.

6. Permeability (Percolation) Soil permeability is probably the most important single factor for estimating the suitability of a site for septic tank absorption fields and pits. It measures the rate at which water or sewage effluent can be taken into and transmitted through different soils. The soil permeability or percolation rate is that quality of 8 soil that enables it to transmit water or air. It can be measured quantitatively in terms of rate of flow water through a cross section of saturated soil in unit time. Permeability rates as used by soil scientists are expressed in inches per hour, whereas percolation rates are expressed by public health officials in minutes per inch. The sets of relative classes of the soil permeability and percolation

rate are listed as follows:

Rate classes	Rates in inches per hour	Rates in minutes per inch
Slow:		
1. very slow	less than 0.06	more than 1000
2. Slow	0.06 - 0.20	300 - 1000
Moderate		
3. Moderately slow	0.20 - 0.60	95 - 300
4. Moderate	0.60 - 2.00	30 - 95
5. Moderately rapid	2.00 - 6.00	9.5 - 30
Rapid		
6. Rapid	6.00 -20.00	3 - 9.5
7. Very rapid	more than 20.00	less than 3

The major factors that affect the permeability or percolation rate are the soil texture and structure. The proportion of sand, silt, and clay have a great bearing on the rate that water is transmitted downward through the soil, Soils high in clay and silt commonly have slower percolation rates than do sandy soils having similar soil structure. Silty and clayey soils have smaller sized pores that restrict the downward movement of water. Sandy soils have larger pores and therefore, allow water to move downward more rapidly.

Fragipans of other cemented pans that are common in moderately coarse and medium textured soils restrict the downward movement of water because of their cemented condition. Solid bedrock also restricts the downward movement of water. A high water table restricts the movement of water because of the saturated condition that results from the high water table.

7. Shrink-swell potential Shrink-swell potential indicates the volume change to be expected when a soil wets and dries. The amount of shrinking and swelling that a soil undergoes on change in moisture content is determined largely by the amount and kind of clay in the soil material. Soils high in clay of the expanding lattice type have a high or very high shrink-swell potential. Other types of clay that have a non-expanding lattice have a low or moderate shrink-swell potential. Soils comprised mainly of sand and silt have a low shrink-swell potential.

The amount of shrink-swell that a soil undergoes has an important effect on the stability of the soil for foundations, conduits for transmitting sewage, buried electric and gas lines, and for other engineering uses that rely on the bearing capacity of the soil.

a. Slope Soil slope has an influence on most uses of soils. Slope gradient effects the rate and amount of runoff of water and the drainage characteristics of soils. It effects the ease of movement of equipment and the extent to which areas must be leveled for non-farm uses of soils; and it determines in part the limitation of soils for septic tank absorption fields.

Soils with a gradient of more than 15 percent have severe limitations for septic tank absorption fields and for dwellings.

C. Factors of Formation
Soil is the product of the interaction of the five factors of soil formation. The factors are parent material, topography, climate, living organisms (especially vegetation), and time. If a factor, such as climate, is varied a different soil is formed.

1. Parent material Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineralogical composition of the soil. Some of the parent materials recognized are loess, glacial till, bedrock, and alluvium.

The characteristics of a given parent material exert an influence on the depth of leaching and weathering of soils. The texture of the parent material has a strong influence on the texture of a soil and on the depth and ease of water movement.

2. Topography Topography, or relief, affects soil formation through its influence on drainage, erosion, plant cover, and soil temperatures. Soils formed on steep slopes may have a locally arid climate even within a humid climate. This arid condition results from the excessive runoff of water. Soils in depressed areas receive additional water from surrounding areas and may have a locally humid climate within arid regions.

3. Climate Climate, with its components of rainfall, snow, temperature, humidity, and wind is the most active of the soil forming factors. Areas having high rainfall and warm temperatures generally have soils that have well developed soil horizons, often to depths of several feet. Areas having low rainfall or extremely cold temperatures generally have soils with very thin soil horizons, often with very little development.

4. Living organisms Plants, animals, insects, bacteria and fungi are important in the formation of soils. Gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity are among the changes caused by living organisms.

Soils formed under grasses generally have thicker and darker surface layers, representing higher organic matter content, than do soils formed under trees.

5. Time Time, usually a long time, is required for formation of soils with distinct soil horizons. The differences in length of time that parent materials have been in place, therefore, are commonly reflected in the degree of development of the soil profile.

III. SOIL NAMES, CLASSIFICATION AND CORRELATION

Soil correlation and naming of soils deals with the definition, mapping, naming, and classification of the kinds of soils in a soil survey area. The purpose of correlation is to guarantee that kinds of soils are adequately defined, accurately mapped, and uniformly named in all soil surveys in the United States. Soil scientists like botanists, study, classify and name soils just as botanists do for plants. Each different soil is studied, and defined in terms of its allowable properties, both physical and chemical, and is assigned a name. This name is then used throughout the United States wherever the soil has the given set of properties common to the soil.

IV. SYSTEMS OF PARTICAL SIZE CLASSIFICATION

This guidebook briefly explains three classification systems -- USDA textural, the Unified, and the AASHO; sets forth some key similarities and differences; and illustrates how to classify soil samples. For detailed infornetion about the Unified and AASHO classifications, references noted in the following paragraphs should be consulted.

Information in this guidebook about the AASHO and Unified engineering soil classification systems was derived mainly from the PCA Soil Primer published by the Portland Cement Association (latest printing, 1962). Chart 3 in this guidebook is adapted from a similar chart in the "Military Standard-Unified Soil Classification System for Roads, Air-fields, Embankments, and Foundations: Mil-Ftd-619A, 1962." This standard was adapted from the Corps of Engineers Waterways Experiment Station Technical Memorandum 3-357 issued in 1953.

Both the unified and AASHO systems are described in several modern textbooks on soil engineering; and the Unified system is explained in Chapter 4 of the "Engineering Field Manual for Conservation Practices" issued by the Soil Conservation Service in 1969.

In 1966 the American Society for Testing and Materials issued "ASTM Designation: D2487-66T, Tentative Method for Classification of Soils for Engineering Purposes" and a companion item, "ASTM Designation: D2488-66T, Tentative Recommended Practice for Description of Soils (Visual-Manual Procedure)." While D2487-66T does not identify the soil classification as Unified, that is the classification described and is considered the authoritative description by the SCS.

In 1968, the American Association of State Highway Officials (AASHO) issued "AASHO Designation: M145-66I, Interim Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes." This is a revision of "AASHO Designation: M145-49," which has been the official classification since 1949 and is the AASHO classification described in the PCA Soil Primer.

Until such time as the American Association of State Highway Officials issues a final decision on the revision, users of the AASHO classification have the option of using either the old or the new. During this interim period, which may last a few years, the SCS will defer to the wishes of the cooperating state highway departments in deciding which classification to use in our soil surveys. The particular AASHO designation used should be indicated.

The changes in the revised AASHO classification are not drastic; the principal change is a new formula for computing the group index, which authors are advised to exclude from the table of estimated physical and chemical characteristics. The group index vill appear only in Table C, which sets forth laboratory data. Hence, for the purpose of entrees in Table B, "Estimated ... characteristics" it is largely immaterial whether the old or the new is used.

The old AASHO classification is described in the PC4 Soil Primer as well as in the official publications of the American Association of State Highway Officials. The new "Designation M145-66I" was distributed to soil scientists and engineers in the SCS with Advisory SOILS-7, May 8, 1969.

The three classification systems differ in several ways; and in order to properly classify soils, the differences should be clearly understood. Briefly, the differences involve particle size terminology and concepts of clay and silt. These are shown by Chart No. 4 and by the list of classification factors that follow:

A, USDA textural classification (Chart 5)

1. Omits all material larger than No. 10 sieve (2.0 mm) except as described by adjective modifiers of basic textural classes.

2. Material larger than No. 10 sieve (gravel, stones, etc.), if estimated, is estimated by volume; if measured, it is measured by weight. For soil classification, estimates by volume need to be converted to estimate6 by weight, which, for most coarse fragments, are greater than estimates by volume. For example, 35 percent coarse fragments by volume equals about 50 percent by weight.

3. Sand is material between No. 270 and No. 10 sieve size (0.05 to 2.0 mm).

4. Gravel is rounded or subangular material between No. 10 sieve size and 3 inches.

5. Clay (< 0.002 mm) and silt (0.002 to 0.05 mm) are materials of specific size.

CHART 4. A COMPARISON OF GRAIN-SIZE LIMITS IN THE 3 CLASSIFICATION SYSTEMS.

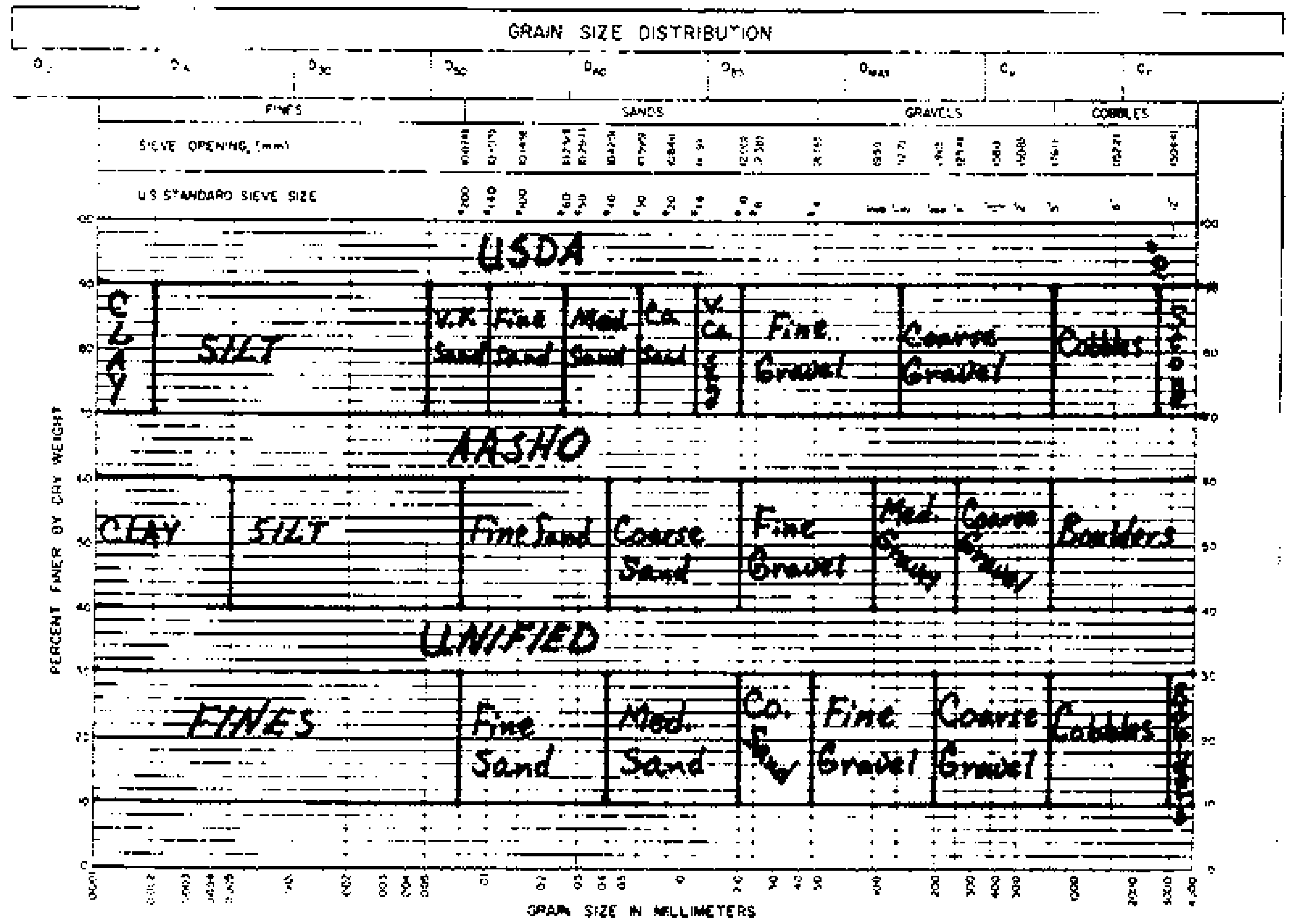
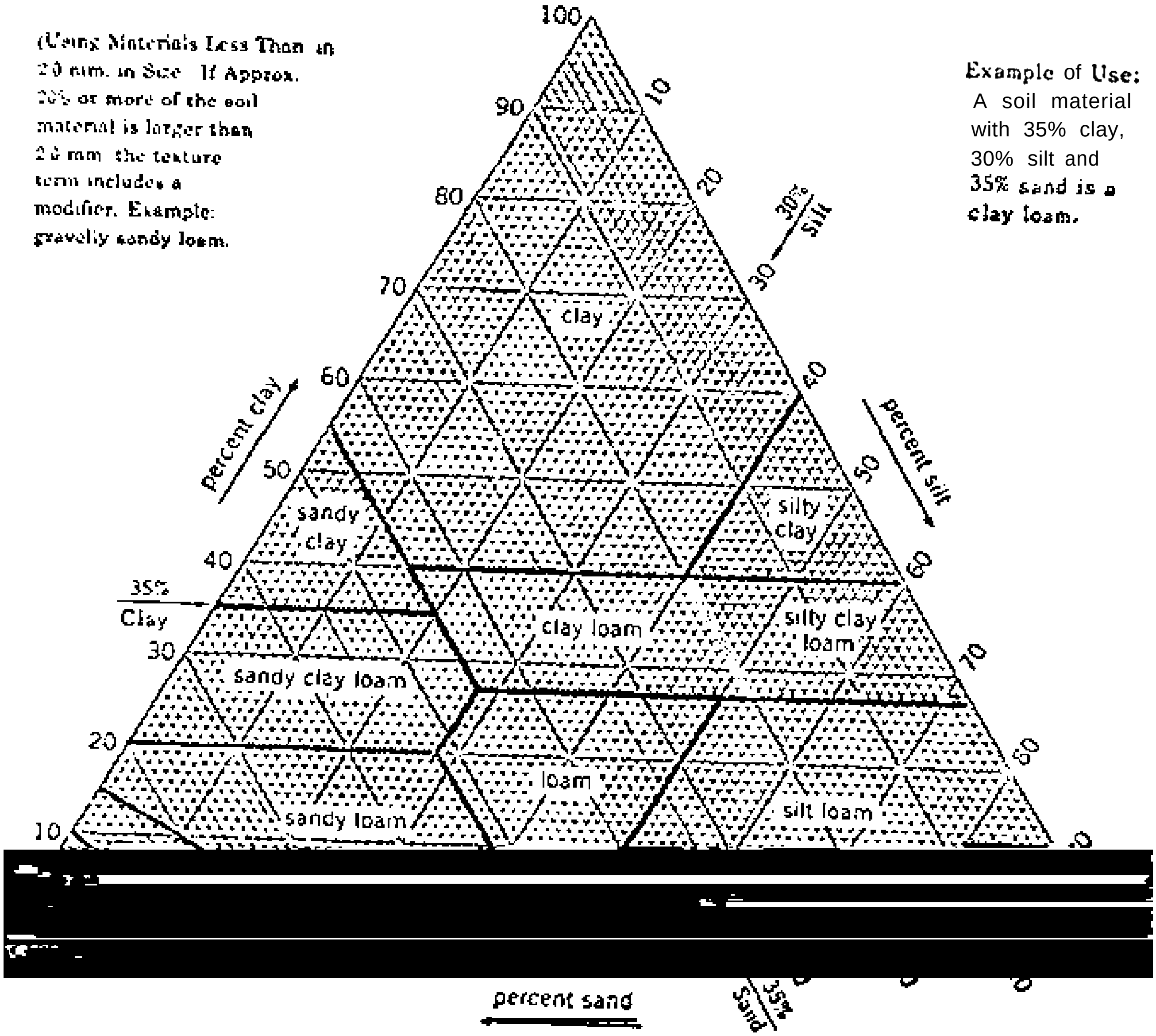


CHART 5. GUIDE FOR USDA SOIL TEXTURAL CLASSIFICATION.

(Using Materials Less Than 2.0 mm. in Size. If Approx. 20% or more of the soil material is larger than 2.0 mm. the texture term includes a modifier. Example: gravelly sandy loam.

Example of Use: A soil material with 35% clay, 30% silt and 35% sand is a clay loam.



B. Unified classification (Chart 6)

1. Uses all material up to 3-inch size in classification.

2. All material percentages are by weight.

3. Sand is material between No. 200 and No. 4 sieve (0.074 to 4.76 mm).

4. Gravel is material between No. 4 sieve size and 3 inches.

5. Clay and silt are not separated by size but by plasticity. The terms silt and clay are used to connote fines exhibiting respectively low and high plasticity.

6. Materials are divided into fine grained or coarse grained at point where 50 percent passes No. 200 sieve.

7. Fine grained materials are further divided on the basis of liquid limit and plasticity index; and, in addition, such materials with enough organic matter to adversely affect engineering behavior are designated.

C. AASHO classification (Chart 7)

1. Uses all material up to 3-inch size in classification.

2. All material percentages are by weight,

3. Sand is material between No. 200 and No. 10 sieve size (0.074 to 2.0 mm). (Fine sands No. 200 to No. 40 (0.074 to 0.40 mm) and coarse sands No. 40 to No. 10).

4. Gravel is material between No. 10 sieve size and 3 inches.

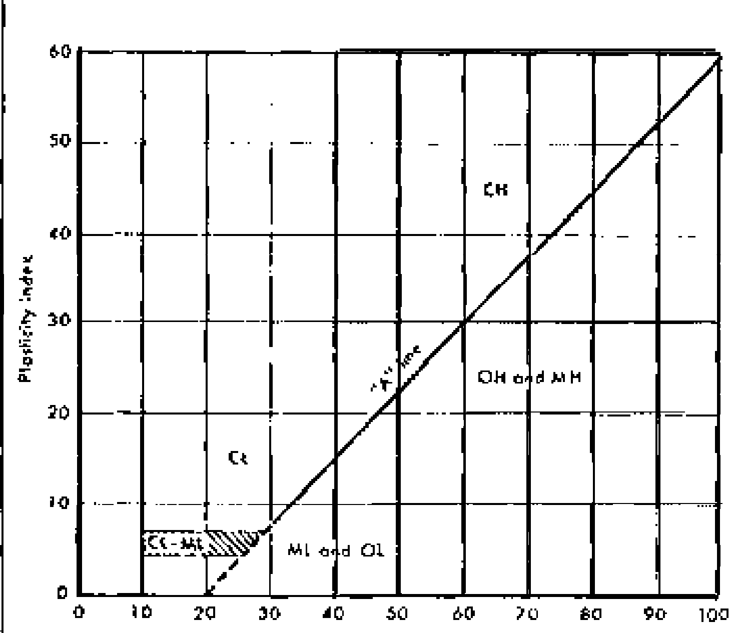
5. Materials divided into granular or silt-clay materials at point where 35 percent passes No. 200 sieve.

6. Clay and silt classified according to liquid limit and plasticity index.

The difference between the engineering and USDA textural definition of "sand" is of special importance. Approximately 50 percent of the material referred to as very fine sands in the USDA textural classification would be of a size smaller than the No. 200 sieve and would, therefore, be considered as "fines" in the Unified and AASHO classifications. Because of this difference, the soil scientist who is familiar with the soil components should determine how much of the soil material classified as very fine sand in the USDA textural classification would be classed as fine grained in the Unified and AASHO classifications.

Chart 6. Unified Soil Classification System

Major divisions			Group symbols	Typical names	Laboratory classification criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent: GW, GP, SW, SP. More than 12 per cent: GM, GC, SM, SC. 5 to 12 per cent: Borderline cases requiring dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM* d / u	Silty gravels, gravel-sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4. Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM* d / u	Silty sands, sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4. Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL	Organic silts and organic silty clays of low plasticity		
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH	Inorganic clays of high plasticity, fat clays		
			OH	Organic clays of medium to high plasticity, organic silts		
	Highly organic soils		Pt	Peat and other highly organic soils		



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterburg limits, suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

**Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

CHART 7. AASHO CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES [1]

General Classification	Granular Materials (35% or less passing No. 200)							Silt-Clay Materials (More than 35% passing No. 200)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6
Sieve Analysis, Percent passing:											
No. 10	50 max.	—	—	—	—	—	—	—	—	—	—
No. 40	30 max.	50 max.	51 min.	—	—	—	—	—	—	—	—
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of Fraction passing No. 40:											
Liquid limit				40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Usual Types of significant Constituent Materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Rating as Subgrade	Excellent to Good					Fair to Poor					

*Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

[1] Highly organic soils (peat or muck) may be classified in an A-8 group. Classification of these materials is based on visual inspection, and is not dependent on percentage passing the No. 200 sieve, liquid limit or plasticity index. The material is composed primarily of partially decayed organic matter, generally has a fibrous texture, dark brown or black color and odor of decay.

These organic materials are unsuitable for use in embankments and subgrades. They are highly compressible and have low strength.

From AASHO Designation: M [illegible]

Generally the sandy clays, sandy clay loams, and sandy loams (mostly fine sandy loams) will be classed as fine grained soils in the Unified system when a large percent of the sand portion consists of very fine sand.

There are some general relationships that exist between these three classification systems that fit most soils, but this does not hold true in all cases. The textural classification does not take into account the plasticity or liquid limit of the material and is based on only that portion of the soil smaller than 2.0 mm (No. 10 sieve.)

Chart 8 gives the expected relationships between the three classification systems. These relationships do not apply to all soils, but with a knowledge of the above properties of the soil and of the differences among the three systems, the table may be used as a guide in making both Unified and AASHO determinations.

V. THE NATIONAL COOPERATIVE SOIL SURVEY

A. Agencies Making Soil Surveys

The Soil Conservation Service and the Forest Service of the U. S. Department of Agriculture are the major agencies making soil surveys in the National Cooperative Soil Survey. The Agricultural Experiment Stations of some states are also actively engaged in mapping soils as are a few other state agencies in some states. The Agricultural Experiment Stations in every state take an active role on field reviews and in the classification and correlation of the soils mapped in the state.

B. How a Soil Survey is Made

A soil scientist walks over the land in the area to be surveyed, and studies the soils, vegetation, and features of the landscape. He identifies the different kinds of soil by digging holes and examining the layers of soil, usually to a depth of about 5 feet. He can make predictions about the nature of the soil material below 5 feet for many kinds of soil that are derived from uniform parent materials. He examines the thickness and arrangement of each layer; its color; the proportion of sand, silt, and clay; the content of gravel and stones; acidity or alkalinity; and organic matter content. He also notes the parent (geologic) material. He evaluates other soil features important to the use of a soil, such as its slope. Then, using his knowledge of soil genesis and soil behavior, he classifies the different kinds of soil and records their boundaries on a map. He describes the kinds of soil in the survey area, the properties of each layer are studied and evaluated, and the important properties are compared with those of similar soils that have been named in the National Soil Classification System. A soil that is unlike all others classified to date is given a new name. About 100,000 kinds of soil are recognized and classified.

Chart 8. [redacted]

USDA Texture Class & Symbol	Unified Symbol	MSHO Symbol	Soil Propcrtics Related to Classification
Clay; silty			
pass No. 4 sieve	GM	A-4	Over 35% fines
	GC	A-6	Over 35% fines

From what the soil scientist has seen and determined by tests and from his knowledge of soil research and experience in the area, he draws inferences concerning the soil qualities that cannot be seen. This is the kind of information that can be useful to farmers, engineers, contractors, planners, homeowners, and others and can prevent costly mistakes.

When the soils of a particular survey area have been named and classified, soil scientistscantransfer experience and information on those soils to other areas. For example, if soil scientists find that a kind of soil in one area is not suitable for a septic-tank filter field, this information is applicable to other areas that have the same kind of soil.

C. How to Use a Soil Survey

Each published soil survey covers the following general topics: How the particular soil survey was made; general soil map; descriptions of soils; use and management of soils; formation, classification, and morphology of soils; additional facts about the county or soil survey area including climate, relief, drainage, water supply, agriculture, industry, and transportation and markets; the literature cited; a glossary; a guide to mapping units; and copies of the detailed soil map.

Each published soil survey includes a small-scale general. soil map and a large-scale detailed soil map. The small-scale general soil map shows the location of major kinds of soil in the county or survey area. Scales are usually about 2 to 5 miles per inch.

The detailed soil map shows all the soils of a particular county or survey area. The detailed map consists of many sheets with a controlled photomosaic base (in those surveys published since 1957). Each sheet is numbered to correspond with the numbers shown on the index to map sheets, which precedes the general soil map. On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. Important soil areas as small as 2 to 3 acres are shown on these map sheets.

The guide to mapping units, which is located before the map section in each recent published soil survey, lists all the soils of' a county or survey area in alphabetical order by map symbol. The guide indicates the page on which each kind of soil is described and the page for the capability unit, range site, or any other group in which the soil has been placed.

1. Reading the Soil Map The soil map in Figure 2 and the legend preceding the map are the foundation of the soil survey. The legend identifies the symbol on the map and tells the name of the dominate soil in the mapped area.

SOIL LEGEND

[illegible]

SYMBOL	NAME
[illegible]	[illegible] loamy sand, 0 to 3 percent slopes
[illegible]	[illegible] sand, [illegible] percent slopes
[illegible]	[illegible]
[illegible]	[illegible]

WORKS AND STRUCTURES

Highways and roads

Poor motor ....

Windmill . . . .

SOIL SURVEY DATA

[illegible]

[illegible]

[illegible]

[illegible]

DRAINAGE

Intermittent

Crossable with tillage implements ....

Not crossable with tillage implements . . . . .

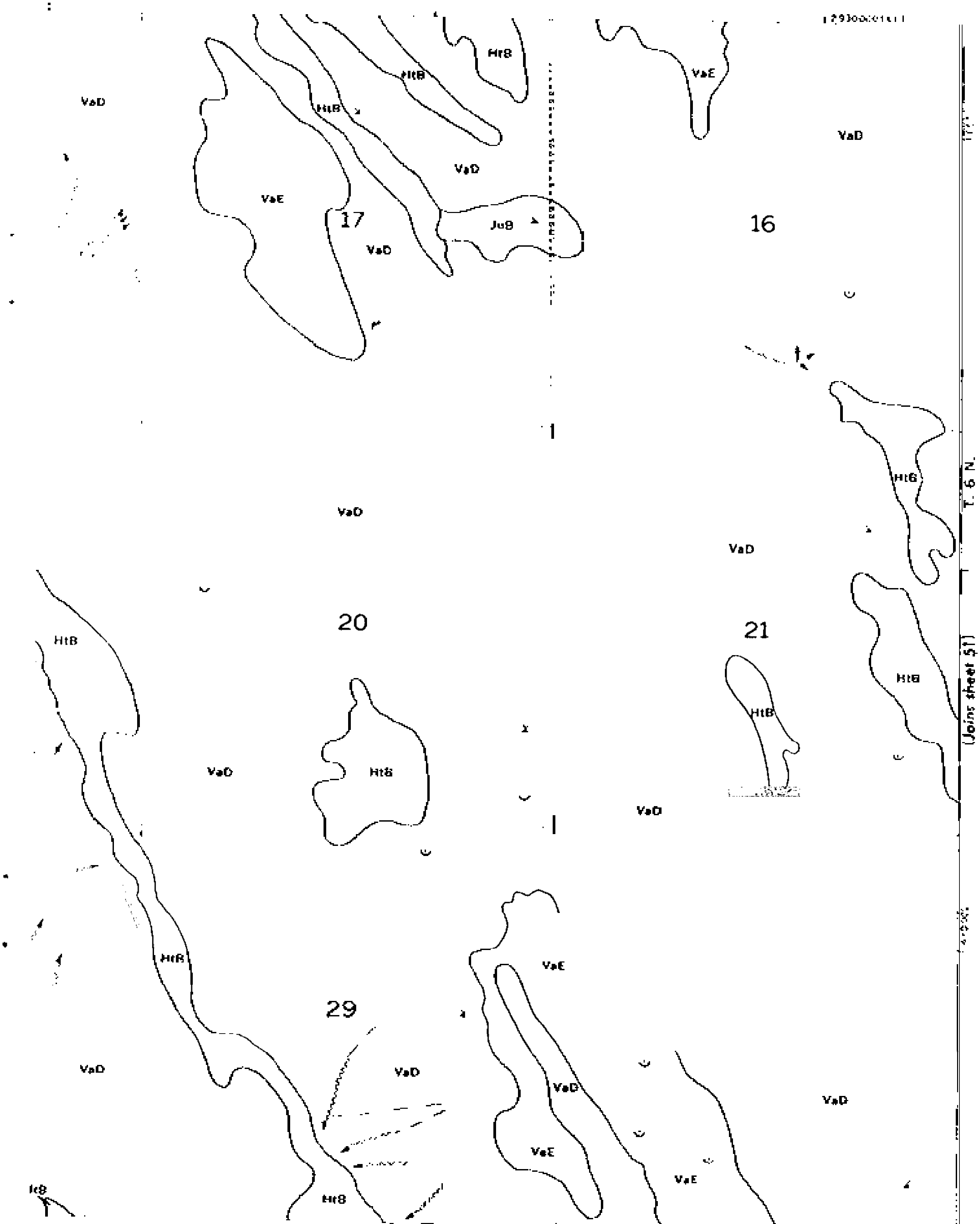
Alluvial fan ....

Drainage end

BOUNDARIES

Land survey division corners ...

Figure 3. PHILLIPS COUNTY, COLORADO — SHEET NUMBER 50



The delineated areas are called "mapping units". The mapping units are composed of one or two dominate kinds of soil and are named after the dominant soil or soil in the mapping unit. Other kinds of soil, too small to delineate, may occur in the mapping unit. The symbol within a mapping unit identifies the kind of soil; and all other areas with the same symbol are the same soil.

As an example, using the soil map in Figure 2 and the accompanying legend preceding the map, the symbol JuB appears on the map in one area. Referring to the legend one finds that JuB is Julesburg loamy sand, 0 to 3 percent slopes. The mapped area is mainly Julesburg loamy sand, 0 to 3 percent slopes, but may also include small areas of other soils such as Haxton loamy sand.

Small blowout areas are shown on the map with a standard symbol shown on the soil legend. The location of several windmills are also shown on the map by standard symbol.

Once the soil is identified in a mapped area, a great deal of information can be interpreted from the name. Some of the items are: (1) slope gradient; depth to seasonally high water table; (3) soil texture; (4) permeability; (5) shrink-swell potential; (6) corrosion potential; (7) presence and depth to bedrock; (8) presence of limiting layers such as a clay substratum; (9) soil reaction; and many others.

2. Limitations of Soil Surveys As previously stated mapped areas of a soil may not consist entirely of the named soil, They may contain inclusions of similar or dissimilar soils. The amount of these inclusions depends on the complexity of the soil pattern on the landscape and the scale of the base map. For many uses of soils it is necessary to make on-site investigations to determine the soil features at the site of the proposed works of improvement. Therefore, the soil survey is most effective for reviewing large land areas, such as subdivisions and not for individual lots.

D. Status of Soil Surveys and Where to Obtain Soil Surveys

1. Status of Soil Surveys Detailed soil surveys have been completed in many counties or areas in the United States. In many other areas the mapping is in progress.

2. Where to Obtain Soil Surveys Published soil surveys are available from several sources. These are the U.S.D.A. Soil Conservation Service, U.S.D.A. Forest Service, Agricultural Extension Service, Agricultural Experiment Stations, and U.S. Senators and Representatives.

Soil surveys arc in progress in many counties or areas, and individual field sheets of the survey can be purchased.

To find out whether a soil survey is available of an area contact the local or state office of the U.S. Department of Agriculture, Soil Conservation Service. The address and phone number of the local or state Soil Conservation Service office is listed in the telephone directory under U.S. Government, Agriculture Department of, Soil Conservation Service.

VI. SOIL INTERPRETATIONS

A. Introduction

Soil interpretations are made by soil scientists and others who examine soils and study soils in the field. They also record the experiences that people have had in using soils for various purposes. The main purpose of soil interpretations, such as those in Chart 9, is to present soils information in a form that potential users will understand. Soil interpretations are prepared by relating soil qualities and characteristics to some defined use of the soil.

Soil interpretations are based on the entire soil as it occurs naturally in nature. The soil scientist examines the soil to a depth of 5 or 6 feet. Soil interpretations, such as those in Chart 9, are based on these depths. If the proposed use requires excavation to depths greater than about 6 feet, geologic investigations will be required.

B. Soil Interpretation Sheets

Soil interpretation sheets, such as the one in Chart 9, are being prepared for all of the soils in the United States. Chart 9 provides interpretations for the Otero series, one of the major soils in Colorado, for many uses.

A soil map and its accompanying legend with a set of these interpretation sheets provides most of the data needed for operational planning and for planning more detailed studies.

Explanation sheets should also be used with the soil interpretation sheets. These sheets explain: (1) how the soil interpretation sheets can be used; (2) what the sheets apply to; and (3) the meaning of the different items on the sheet.

Several items need to be re-emphasized with regard to the use of the soil interpretation sheets.

1. The interpretations do not eliminate the need for on-site sampling, testing, and study of specific sites for design and construction of engineering works. They are valuable in planning of more detailed studies. They are also useful in determining suitability of large areas for different uses such as residential development, farming, recreation, and others.

SCS-Soils-5
4-71

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS

Otero Series

MLRA: 69

LSL 3/26/71

Deep, well drained to somewhat excessively drained, calcareous soils formed in coarse textured, wind modified alluvium. Typically, Otero soils have light brownish gray, very friable sandy loam A horizons, and very pale brown sand loam C horizons.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Depth from surface (inches)	Classification: USDA texture	Classification: Unified	Classification: AASHO	Coarse fract. >3 in. %	Percentage less than 3 in. passing sieve no.: 4	10	40	200	LL	PI	Permeability in./hr.	Avail. water capac. in./in.	Soil reaction pH	Shrink-swell potential
0-60	sandy loam	SM	A-2	< 1	95-100	85-100	50-80	20-35	5-16	0-10	6.0-20.0	.11-.13	7.4-8.4	Low

Flood hazard: Rare

Wetness: Seasonal high water table at 5 to 7 feet

Hydrologic group: B

Depth to rock: >60"

Corrosivity - uncoated steel: Low

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Topsoil	Good
Sand	Poor-excessive fines
Gravel	Unsuited-No gravel
Roadfill	Good

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING SELECTED USES

Septic tank absorption field	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Sewage lagoons	Severe: Rapid permeability
Dwellings w/o basements	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Dwellings w/ basements	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Shallow excavations	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Sanitary land fills (trench type)	Severe: Rapid permeability
Local roads and streets	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Pond reservoir areas	Rapid permeability
Embankments, dikes, and levees	Piping hazard

Chart 9 (cont.)

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp areas	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
Picnic areas	Slight: 0-8 percent slopes Moderate: 8-15 percent slopes
[redacted]	

Phases of series	Capability	Soil loss K	Soil loss T				
Otero sandy loam, 1 to 9 percent slopes	VIe						

WILDLIFE HABITAT SUITABILITY

Phases of series	Potential for: Grain and seed crops	Grasses, legumes	Wild herbaceous plants	Hardwood trees and shrubs	Coniferous plants	Wetland food and cover	Shallow water devel.	Potential for: Openland wildlife	Woodland wildlife	Wetland wildlife

WOODLAND SUITABILITY

Phases of series	Ordination	Potential productivity: Important trees	Site index	Woodland management hazards: Erosion hazard	Equipment limitations	Seedling mortality	Windthrow hazard	Plant competition	Suitable species: To favor	To plant

[illegible] for other management hazards, supplementary woodland products, air-dry herbage per acre under medium canopy, etc.

RANGE

Phase of series	Range site name	Climax veg. and potential yields of air-dry herbage (lbs./ac.)
Otero sandy loam	Sandy plains	Blue gramma, sand dropseed, sand reedgrass, little bluestem, sedge, buckwheat, galetta.

OTHER

Soil Conservation Service
Denver, Colorado

"SE AND EXPLANATION OF SOIL INTERPRETATION SHEETS

INTRODUCTION

The interpretation sheets provide a brief soil description, agricultural use interpretations, estimated physical and chemical properties important to engineering uses of soil, the suitability of soils as resource materials, and limitations and factors affecting the use of soil, and other soil properties or behavior characteristics.

The interpretations will not eliminate the need for on-site sampling, testing, and study of specific sites for design and construction of engineering works and various uses. The interpretation sheets should be used primarily to plan more detailed field investigations to determine the conditions of the soil at the proposed site for the intended use.

The interpretation sheets should be used only with detailed soil surveys that have bee" prepared according to standard procedures of the Nations1 Cooperative Survey. It is not intended that they be used with "land-type surveys," low intensity surveys, or general soil maps. The Interpretations are for soils in their natural site and not for disturbed areas that are altered by cut or fill operations.

When the interpretation sheets are used in connection with delineated soil areas on soil maps, the information pertains to the dominant soil for which the soil area is named. Other soils, too small in area to map out, may occur within the soil map are*. The interpretations ordinarily do not apply to the included soils. More detailed studies are required if small, specific sites are to be developed or used within 8 given soil area. For example, a soil map area bearing the name Weld loam, 0 to 3 percent slopes, also can include small, unmappable areas of other soils, such as Colby or Raw. The interpretations apply only to the Weld part of the delineated soil area, and not to the entire soil area.

SOIL DESCRIPTION

This brief description points out the major layers in the soil profile, and describes their main features. A more specific soil description can be obtained from the local Soil Conservation Service [redacted]

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

Horizon Depth - The major parts of the soil profile are indicated. Soil horizons that are similar are grouped in this

Liquid Limit

The liquid limit (L.L.) is the moisture content at which a soil passes from a plastic to a liquid state.

Plastic Limit

The plastic limit (P.L.) of soils is the moisture content at which a soil changes from a semi-solid to a plastic state.

Permeability - Values listed are estimates of the range in rate and time it takes for downward movement of water in the major soil layers when saturated, but allowed to drain freely. The estimates are based on soil texture, soil structure, available d.t. an permeability and infiltration tests, and drainage observations of the water movement through soils. In most cases, particularly with soil horizons that are high in clay or organic matter, permeability rates under unsaturated conditions are considerably higher than the values given here. On a given soil type, percolation through the surface layer varies according to land "se and management . . well as with initial moisture content.

Available Water Capacity - The available water capacity is give" in inches per inch of soil for the major horizons. These estimates are for cultivated soil. with moderate structure and organic matter content, and average bulk densities. Available water capacity of the soil in inches is the difference between field capacity (1/3 atmosphere) and the wilting percentage (15 atmosphere) times bulk density times the thickness in inches of the soil. The water retention by soil is related to the particle size and to the arrangement and size of the soil pores. Pine-textured soils tend to have higher water retention due to small Pores than do sandy rails with large pores. Estimates of the available water capacity for soils with normally high water tables may appear meaningless until on. considers the possibility of artificial drainage or the natural lowering or the water table during dry seasons, or late summer or fall. Soils of the same series vary from place to place; therefore, values can deviate considerably from those listed.

Soil Reaction - Soil reaction or the intensity of soil acidity or alkalinity is expressed in [A--- the logarithm of the reciprocal of the H-ion concentration. A pH of 7 is netural, lower values indicate acidity and higher values show alkalinity.

Shrink-Swell Potential - Indicates tbc volume change to be expected of the soil material with changes in moisture content.

OTHER SOIL PROPERTIES OR BEHAVIOR CHARACTERISTICS

These items have no rating, but have comments relative to any observations made by the soil scientist during his survey. If no observations were made on one of the soil properties there are no comments.

Flood hazard
Wetness
Corrosivity - uncoated steel
Corrosivity - concrete
Hydrologic group
Depth to rock

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Topsoil - Soil as a source of topsoil is rated on the basis of the characteristics and thickness of the surface soil, difficulty of obtaining the material, and presence of gravel and cobbles. Three ratings are recognized: good, fair and poor. These ratings are intended for use by nurserymen landscape architects, highway engineers, and others concerned with establishing vegetation to cover slopes, road shoulders, waterways, lawns and golf course, and wherever suitable soil material is needed to establish vegetation. The soil is rated from the surface down to a minimum of 8 inches.

Distance from area of intended use, and presence of weeds, soil-borne diseases and insects, and relation of the characteristics of topsoil to those of the site where it is to be used is not considered in this classification. These are important factors to be considered in on-site evaluation of a potential source of topsoil.

Sand and Gravel - Suitability of the soil as a source of sand and/or gravel for construction material for use in concrete, plaster, mortar, etc., is given for material to a depth of 5 feet. In some soils the sand and/or gravel extends downward to depths much below 5 feet, whereas in other areas of the same soil, unsuitable material occurs just below 5 feet. It also should be recognized that some soils that are rated as unsuitable may have sand and/or gravel at a depth below 5 feet. Where the suitability is in question, individual test pits will be needed. The general ratings are: good, fair, poor, and unsuitable.

Roadfill - Suitability of a soil as a source or roadfill is given to a depth of 5 feet. In some areas the same material may extend for several more feet, but in others the material below 5 feet can be different. The general ratings are good, fair, and poor.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING SELECTED USES

Three degrees of limitations are used on the interpretation sheet as follows:

Slight - Relatively free of limitations or limitations are easily overcome.
Moderate - Limitations need to be recognized, but can be overcome with good management and careful design.
severe - Limitations are severe enough to make use questionable.

The interpretations will not eliminate the need for on-site study, testing, and planning of specific sites for the design and construction for specific uses. The interpretations can be used as a guide to planning more detailed investigations and for avoiding undesirable sites for an intended use. By using the soil map and interpretations, it is possible to select sites that have the

Sewage lagoons - The limitation of soil is rated for use as water-retention. Ratings are based upon undisturbed soil.

Dwellings w/ no basements

" " " " " " " "

Shallow Excavation - Excavations are made for basements, trenches for utilities, cemetery burial lots and sanitary landfills. Swamp, rock outcrops and peat bogs are considered unsuitable. The entire soil profile will be considered. Textures are an average of the top 5 feet, except strongly contrasting substrata should be considered separately; i.e., loam over gravel. Ratings are based on difficulty of removal and the caving hazard and not upon backfill placement and workability.

Sanitary land fills (trench type)

Local roads and streets are considered low cost roads and residential streets, construction of which involves limited cut and fill and limited preparation of subgrade. Streets are normally paved with low cost paving. The rating is for the use of the soil in place. Important soil properties for this use are slope, depth to hard rock, water table, flood hazard, presence of stone or cobble, and the supporting capacity. Soils are placed in their AASHO class to help evaluate their supporting capacity.

Pond reservoir areas

Soil features important for pond reservoir areas are those that affect their suitability for water impoundment. Of primary concern are those soil features that affect the seepage rate.

Embankments - Low embankments are used for farm ponds or reservoirs, dikes and levees. Heights of embankments considered are 4 to 15 feet. Material in the ● mbwlm=nt is assumed to be compacted to at least 80 percent of Standard Proctor at optimum moisture content. Stability, compaction characteristics, compacted permeability, susceptibility to piping, and erosiveness are important soil qualities. The entire soil profile except for the A.1 horizon will be considered. Accessibility of materials is not considered.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Campsites (Intensive Use) - Areas to be used for tent and small camp trailer sites and the accompanying Of outdoor living. Little site preparation other than shaping and leveling tent and parking areas is required, and the site should be suitable for heavy traffic by humans, horses, or vehicles. Swamps, marshes, rock outcrops and the like are considered very severely limited. Ratings are based on soil properties and qualities only, and do not include other features that may be important in site selection. Suitability of the soil for supporting vegetation is a separate item to be considered in the final evaluation of the site. Problems of sewage disposal, water supply and access roads are not considered in the ratings.

Picnic Area (Intensive Use) - This applies to soils considered for intensive use as park-type picnic ● r=.=. It is ● =MCd that most vehicular traffic will be confined to access roads. Soil suitability for growing vegetation is not a part of this guide but is an item to consider in final evaluation of . site. Ratings are based on soil properties and qualities only, and do not include other features that may be important in site selection. Suitability of the soil for supporting vegetation is a separate item to be considered in the final evaluation of selecting sites for this use. Problems of water supply and sewage disposal are not considered in the rating.

Playgrounds (Intensive Use) - This applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments. Soil suitability for growing and maintaining vegetation is not a part of this guide but is an important item to consider in final evaluation of . site.

Paths and trails

Soil limitations for foot paths and bridal trails are based on the following properties: wetness, flooding, slope, surface soil texture, coarse fragments on the surface, and rockiness or stoniness.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

The land capability and crop yield predictions are given for both non-irrigated and irrigated areas. These are shown for each of the slope groups on which the soil occurs. The capability classification is a grouping of soils that shows in a general way how suitable they are for most kinds of farming. The eight capability classes is the broadest grouping and are designated by Roman numerals I through VIII. Class I soils have the fewest limitations, and Class VIII soils have the greatest limitations for farming.

The yields shown are expected yields that are obtained under improved management.

WILDLIFE HABITAT SUITABILITY

Ratings are based on the ability of the soil to produce food and cover for wildlife.

WOODLAND SUITABILITY

Woodland or Windbreak Suitability, indicates the suitability of the soil to produce trees.

RANGE

The Range Site is a classification used by SCS to catalogue kinds of land that are capable of producing essentially the same kind and amount of climax or original vegetation.

2. The interpretations are based on the soils as they occur in nature and not for disturbed areas that have been altered by cut or fill operations.

3. The interpretations apply to the named soil of a particular mapping unit on the soil map. They do not apply to other soils that are inclusions within the soil delineation.

4. The soil interpretation sheets are designed for use with detailed soil surveys of the National Cooperative Soil Survey.

C. Single Factor Maps

Single factor maps or stoplight code maps can be prepared as an aid in highlighting soil survey areas for land use planning. These factor maps are an effective way of showing areas on the soil map that have slight, moderate, or severe limitations for a particular use.

Factor maps can easily be prepared using a copy of a published map sheet. The soils on the map sheet are identified and the appropriate interpretation sheets are selected. If the interpretation needed is septic tank filter fields the rating for this use can be selected from each of the interpretation sheets. The procedure is to color all areas on the map green (as a go sign) that have slight limitations. Areas with moderate limitation are colored yellow (caution), which indicates the problems are probably economical to overcome. Areas with severe limitation are colored red (stop). A severe limitation does not prevent a soils use for this purpose, but it does indicate that the problems are severe enough that extreme measures are needed to overcome the limitations and usage for this purpose may not be practical.

A system of cross-hatching, as shown in Chart 10, can also be used to make single factor maps. Chart 10 is a portion of Sheet 55, of the Phillips County, Colorado, published soil survey that has been cross-hatched to show soil limitations for septic tank filter fields.

D. Soil Limitations and Suitability as Source of -- Rating Sheets

"Soil limitations" and "suitability as source of" rating sheets have been developed for use in rating soils for selected uses.

1. Soil Limitations for

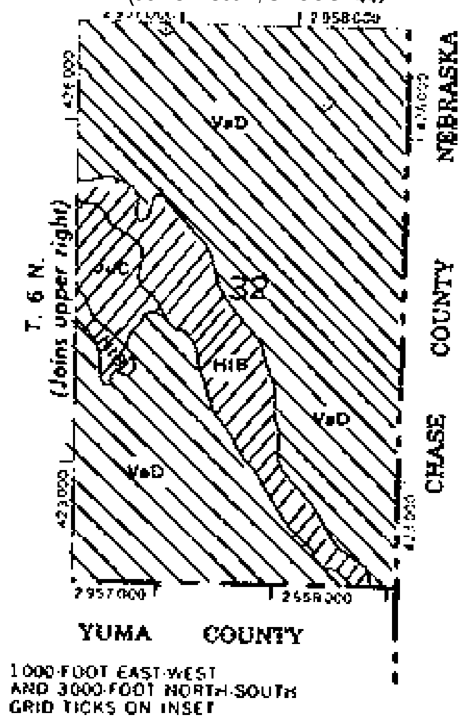
a. Septic tank absorption fields The septic tank absorption field is the soil absorption system for sewage disposal. It is a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil. Criteria and standards used for rating soils are based on the limitations of the soil to absorb effluent. Three groupings are made: Slight, moderate, and severe.

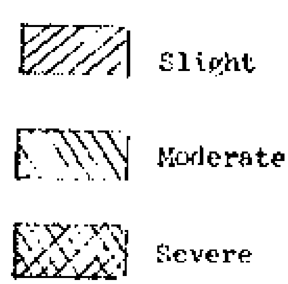
Chart 10. Soil Limitations for Septic Tank Filter Fields

PHILLIPS COUNTY, COLORADO — SHEET NUMBER 55

R. 42 W.

(Joins inset A, sheet 44)





Some factors important in determining the limitations of a soil for an absorption field are: (1) local experience and records of performance of existing filter fields, (2) permeability of the subsoil and substratum, (3) depth to consolidated rock or other impervious layers, (4) flooding, (5) seasonal and annual ground water level, and (6) soil slope. These factors are discussed in more detail in the following paragraphs.

Records of recorded observations of correctly designed and installed septic tank systems that failed within a few years after installation are indicators of a severe soil limitation. Clues to watch for besides information from the homeowner, are rank plant growth, seepage, or odor in the vicinity of the absorption system.

Soils with moderate to very rapid permeability are rated as having a "slight" soil limitation. Soils with a permeability at the slower end of the moderate range (about 1.0 to 0.60 inches per hour) are rated as having a "moderate" soil limitation unless measured results or experience show a "slight" limitation. Soils with a permeability rate of less than 0.60 inches per hour are rated as having a "severe" soil limitation if used for an absorption field.

Although soils with rapid permeability have slight soil limitations, it should be noted that a contamination hazard may exist if water supplies, streams, ponds, lakes, or water courses are nearby and receive seepage from the absorption field (see coarse-textured soils).

Experience has shown that soils having percolation rates: (1) faster than 45 minutes per inch function satisfactorily, (2) between 45 and 60 minutes per inch have moderate limitations, and (3) slower than 60 minutes per inch have severe limitations when used as absorption fields for septic tanks. These rates are those obtained by the auger-hole method.

Field percolation tests made by local health departments are usually conducted under a wide range of soil moisture conditions and, therefore, the results should be interpreted with caution. <u>Results are reliable only if the moisture is at or near field capacity when the test is run.</u> In fact, nearly impermeable soils on which absorption fields have failed can give high percolation test results after periods of drought. In addition to soil properties that influence percolation rates, changes in the micro-organisms in the soil may also help or hinder the functioning of the absorption field after it is in operation. Because the methods of measuring percolation and permeability are different, the correlation between the two values is imperfect. Use the information in Table 1, Page 40.

Table 1. Soil Limitation Classes for Septic Tank Absorption Fields

Soil Properties	Soil Ratings in Terms of Limitations		
	Slight	Moderate	Severe
Permeability class 1/	Rapid 2/ moderately rapid, and upper end of moderate	Lower end of moderate	Moderately slow and slow 3/
Hydraulic conductivity rate (Uhland core method)	More than 1.00 inch/hr. 2/	1.0 to 0.60 inch/hr.	Less than 0.60 inch/hr.
Percolation rate (Auger hole method)	Faster than 45.0 min./inch 2/	45 to 60 min./inch	Slower than 60 min./inch
Depth to water table 4/	More than 72 inches	48 to 72 inches	Less than 48 inches
Flooding hazard	Not subject to flooding	Not subject to flooding	Subject to flooding
Slopes	0 to 8%	8 to 15%	More than 15%
Depth to hard rock, 4/ bedrock, or other impervious materials	Over 72 inches	48 to 72 inches	Less than 48 inches

1/ Class limits are the same as those suggested by the Work-Planning Conference of the National Cooperative Soil Survey. The limitation ratings should be related to the permeability of soil layers at and below depth of the tile line.

2/ Indicate by footnote where pollution to water supplies is a hazard.

3/ In arid or semiarid areas soils with moderately slow permeability may have a moderate limitation.

4/ Based on assumption of tile depth of 2 feet in the soil.

A seasonal water table should be at least 4 feet below the bottom of the trench at all times for soils rated as having a slight limitation. 1/

Soils with water tables less than 4 feet below the bottom of the trench for extended periods have a severe limitation. In humid areas, soil drainage classes provide clues to soil limitations. 2/ Well drained and some moderately well drained soils that are readily permeable have slight limitations. Some somewhat poorly drained soils and most moderately well drained soils that are permeable have moderate limitations. Poorly and very poorly drained soils have severe limitations.

Impervious layers including rock formations should be 4 feet or more below the bottom of the tile trench floor.

Creviced or fractured rock without an adequate soil cover permits unfiltered sewage to travel long distances through old or new aquifers, as in deeply cracked limestone. One should have at least 4 feet of moderately coarse or finer textured soil material between the bottom of the tile trenches and such rock.

Coarse-textured soils (loamy sand, sand, and gravel) are relatively poor filtering materials. These soils permit unfiltered sewage to travel long distances. Ratings on the basis of permeability alone should be supplemented by a statement about the hazard of contaminating nearby water supplies.

Soils in drainageways and on flood plains--Soils that flood have severe limitations even if the permeability rate is high and the ground water level is below 4 feet. Floodwaters interfere with the functioning of the filter field and carry away unfiltered sewage. Without protection, areas subject to flooding should not be considered for on-site sewage disposal systems.

Slopes of less than 8 percent offer the best sites from the standpoint of construction and successful operation of an absorption field. Mechanical problems of layout and construction increase with steepness of slope. Lateral seep or down-slope flow is a problem on sloping soils, especially where bands of impermeable material occur within the 4 foot depth. Large rocks, boulders, and rock outcrops increase construction costs. The tile grade is difficult to maintain if the obstacle cannot be removed. Trench lines can be installed and grade maintained around these obstacles on nearly level soils.

1/ Manual of Septic Tank Practice, U.S. Department of Health, Education, and Welfare, Public Health Service, pp.92. 1967.

2/ Where relief permits, the effective depth above a water table can be increased by appropriate fill.

Detergents in solution are readily transmitted through sonic soils and may contaminate ground water supplies. Sodium salts from water softeners and other sources tend to disperse the clay in the soil and reduce the effectiveness of the absorption field.

Sample statements for septic tank absorption fields:

(1) Moderate - Slopes 10 to 15 percent.
(2) Severe - Slow permeability.

b. Sewage lagoons A sewage lagoon is a shallow lake used to hold sewage for the time required for bacterial decomposition. Sewage lagoons require consideration of the soil for two functions, (1) as a vessel for the impounded area, and (2) as soil material for the dam. The requirements for the darn are the same as for other embankments designed to impound water. (See Col. 12--Embankments, dikes, and levees.) Adequate soil material must be available that is suitable for the structure, and when properly constructed the lagoon must be capable of holding water with minimum seepage. The material should be free of coarse fragments (over 10 inches in diameter) that interfere with compaction.

Soils placed in the Unified soil classification groups GC, SC, and SM are satisfactory for lagoon bottom. The coarse groups with few of the fines (GW, GP, SW, and SP) have severe limitations and are poorly suited. The groups consisting of soils high in organic matter (OL, OH, and Pt) also have severe limitations and are poorly suited. Soil material of the other Unified classification groups (GM, CL, CH, ML, and MH) are suitable when properly compacted or if used in combination with soils classified as GC, SC, and SM.

Soil requirements for basin floors of lagoons are: (1) Slow rate of seepage, (2) even surface of low gradient and low relief, and (3) little or no organic matter. Specifications for lagoons state the depth of liquid should be not less than 2 feet and generally not more than 5 feet, that the floor should be level or nearly so, and that the materials for the basin floor should be so nearly impervious as to preclude excessive loss of liquid. 1/ The relatively impervious soil material should be at least 4 feet thick. This is especially important where the local water Supply is from shallow wells that may become contaminated. Using Table 2, Page 43, as a guide, the following items are to bc considered in evaluating the degree of limitations for soils forming the lagoon impoundment site:

1/ Community Sewage Systems "Design Guides for Sewage Stabilization Basins," Series No. 1833. December 8, 1960, Federal Housing Administration.

Table 2. Soil Limitation Classes for Lagoons

Soil Properties	Limitation Class		
	Slight	Moderate	severe
Depth to water table (seasonal or normal)	Over 60 inches	40 to 60 inches	Less than 40 inches
Permeability	Less than 0.60 inch/hr.	0.60 to 2.0 inch/hr.	Over 2.0 inch/hr.
Depth to bedrock	More than 60 inches	40 to 60 inches	Less than 40 inches
Slope (percent)	Less than 2	2 to 7	Over 7
Reservoir site material 1/ (Unified grouping)	GC, SC, CL, and CH	GM, ML, SM, and MH	GP, GW, SW, SP, OL, OH, and Pt
Coarse fragments, under 10" in diameter, by percent volume	Less than 20	20 to 50	Over 50
Percent of' surface area covered by coarse fragments over 10" diameter	Less than 3	3 to 15	Over 15
Organic matter (percent)	Less than 2	2 to 15	Over 15
Flooding hazard	Not subject to flooding	Not subject to flooding	Subject to flooding

1/ Mainly for lagoon floor, For interpretations about material for embankments see "Embankments, dikes, and levees."

Soils classified in the Unified soil classificationsvstem are

(3) There must be at least 4 feet of relatively impervious material between the bottom of the lagoon and the seasonal water table or cracked and creviced bedrock.

Organic matter--Moderate to high amounts of organic matter are unfavorable in the basin floor even though it is underlain by suitable soil material. Organic matter promotes aquatic plant growth which is detrimental to proper functioning of the lagoon.

Coarse fragments--Fragments more than 10 inches in diameter interfere with manipulation and compaction of the soil material in the process of smoothing the basin floor and are, therefore, undesirable in sewage lagoon sites.

Sample statements for Lagoons:

(1) Severe - Rapid permeability
(2) Moderate - 50 inches to hard rock
(3) Moderate - Many stones
(4) Severe - Slopes

c. Shallow excavations Shallow excavations are those that require excavating or trenching to a depth of 5 or 6 feet or less. Such uses include underground utility lines (pipelines, sewers, cables), cemeteries, sanitary landfills, basements, and "pen ditches, although some supplemental criteria are needed to establish limitation ratings for pipelines, and cemeteries and other uses. For example, for pipelines, additional interpretations about shrink-well potential and corrosivity may be needed; and, for cemeteries, additional interpretations about landscaping are needed. Most of the anticipated uses involve backfilling, but some, such as basements and open ditches, do not. Desirable soil qualities and characteristics are good workability, moderate resistence to sloughing, gentle slopes, absence of' rock outcrops and big stones, and no flooding. Table 3, Page 46, gives limitation ratings for shallow excavations.

Sample statements for shallow excavations:

(1) Moderate - Bedrock at 50 inches.
(2) Severe - Flooding.

d. Dwellings Ratings are for undisturbed soils that are evaluated for single-family dwellings and other structures with similar foundation requirements. Excluded are buildings of more than three stories and other buildings with foundation loads in excess of those equal to three-story dwellings. The emphasis for rating soils for dwellings in on foundations; but soil slope, and susceptibility to flooding and other hydrologic conditions, such as seasonal wetness, that have effects beyond those related exclusively to foundations, are considered too. The properties affecting the foundation support are those that affect bearing capacity and settlement

Table 3. Soil Limitation Classes for Shallow Excavations

Items affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Soil, drainage class	Excessive, somewhat excessive, and well drained	Moderately well drained	Somewhat poorly, poorly, and very poorly drained
Seasonal water table	Below 60 inches	Between 30 and 60 inches	Above 30 inches
Flooding	None	None	Subject to flooding
Slope (percent)	0 to 8	8 to 15	More than 15
Texture of depth to be excavated 1/ 2/	fsl, sl, 1, sil, sicl, scl	si3/ cl, sc, all gravelly types	c4/ sic4/ s, ls, organic soils, all very gravelly types
Depth to bedrock 5/	More than 60 in.	40 to 60 inches	Less than 40 inches
Stoniness (classes) 6	0, 1	2	3, 4, 5
Rockiness (classes) 6	0	1	2, 3, 4, 5

1/ Texture is used here as an index of workability and sidewall stability.

2/ If soil contains a thick fragipan, duripan, or other material difficult (but not impossible) to excavate with handtools, increase the limitation rating by one class unless it already is severe.

3/ If soil will stand in vertical cuts, like loess, reduce rating to slight.

4/ If friable, like that in some kaolinitic Paleudults, reduce rating to moderate.

5/ If bedrock is soft enough so that it can be dug out with ordinary handtools or light equipment, such as back hoes, reduce moderate and severe ratings by one class.

6/ See definitions in Soil Survey Manual, pp. 217-221.

under load and those that affect excavation and construction cost. The properties affecting bearing strength and settlement of the natural soil are densit:;, wetness, flooding, plasticity, texture, and shrink-swell behavior. Texture and plasticity (Atterberg limits) are inferred from the Unified Soil Group. Properties influencing the ease and amount of excavation are wetness, slope, depth to bedrock, stoniness, and rockiness. Also considered are soil properties, particularly depth to bedrock, that. influence installation of utility lines, such as those between the dwellings and the trunk lines. Excluded are limitations for soil corrosivity for steel and concrete, septic tank absorption fields, and landscaping; such limitations are provided in separate interpretations. Onsite investigations are needed for specific placement of buildings and utility lines, and for detailed design or foundations. All ratings are based on undisturbed soils to a depth of five feet. Table 4, Page 48, gives limitation ratings for dwellings.

Sample statements for dwellings:

(1) Severe - High shrink-swell.
(2) Moderate - Slopes 10 to 15 percent.

c. Sanitary landfill Soil surveys are a valuable tool in selecting alternate sites for a proposed sanitary landfill operation. They are not a substitute for detailed geologic investigations because soil borings are normally limited to depths of 5 or 6 feet. Thus they do not provide data needed at greater depths.

Soil surveys are especially useful in preliminary determinations of those sites that are not well suited for sanitary landfill operations, thus saving the time and expense of more detailed investigations. They can also indicate those sites where favorable soils are located and where additional investigations appear warranted.

In some areas the soil properties below 5 to 6 feet can be predicted with a reasonable degree of accuracy. Predictions relative to probable depth to seasonal high water table or bedrock can be useful in planning for detailed investigation of those potential sites which warrant further consideration. The design engineer still needs to determine actual soil conditions to the depth necessary to obtain valid data for design purposes.

Trench type landfill The trench type sanitary landfill, Table 5, Page 49, is a dug trench in which refuse is buried. The refuse is covered with at least a 6 inch layer of compacted soil material daily, or more frequently if necessary. Soil material excavated in digging the trench is used for this purpose. A final cover of soil materiel at least 2 feet thick is placed on the landfill when the trench is full.

Table 4. Soil Limitation Classes for Dwellings 1/

Item	Degree of soil limitat[illegible]		
[illegible]	[illegible] what excessively, well Without basements: Excessively, somewhat excessively, well, moderately well	[illegible] Without basements: Somewhat poorly	
Seasonal water table (seasonal means 1 month or more	With basements: Below 60 inch Without basements: Below 30 inch	With basements: Below 30 inch Without basements: Below 20 inch	
Flooding	None	None	
Slope 4/ (percent)	0 to 8	a to 15	
Shrink-swell potential	Low	Moderate	
Unified soil group	GW, GP, SW, SP, GM, GC, SM, SC	ML, CL	
Potential frost action 6/	Low	Moderate	
Stoniness 7	Classes 0 to 1	Class 2	Classes 3, 4, & 5
Rockiness 7/8/	Class 0	Class 1	Classes 2, 3, 4 &
Depth to bedrock 8/	With basements: More than 60 in. Without basements: More than 40 in.	With basements: 40 to 60 in. Without basements: 20 to 40 in.	With basements: Less than 40 in. Without basements: Less than 20 in.

By reducing the slope limits 50 percent, this table can be used for evaluating soil limitations for shopping centers and other small industrial buildings with foundation requirements not exceeding those of ordinary three-story dwellings.

2/ Some soils rated as having moderate or severe limitations may be good sites from an aesthetic or use standpoint but require more preparation or maintenance.

3/ Soil Survey Manual, pp. 169-172.

4/ Reduce slope limits 50 percent for those soils susceptible to hillside slippage.

5/ Upgrade to moderate if MH is largely kaolinitic, friable, and free of mica.

6/ Use this item only where frost penetrates to assumed depth of footings and soil is moist during freezing weather. See section "Potential Frost Action" for guidance to classes.

7/ Soil Survey Manual.

8/

Table 5. Soil Limitations for Sanitary Landfill
Trench Type 1/

Soil property		Degree of soil limitation		
		Slight 2/	Moderate 2/	Severe
Depth to seasonal high water table		Not class determining		
		More than 72 inches		Less than 72 inches
Soil drainage Classes		Excessively, somewhat excessively, well-and some 3/ moderately well drained	Somewhat poorly, and some 3/ moderately well-drained	Poorly and very poorly drained
Flood hazard		None	None	Soils subject to flooding
Permeability 4/		Less than 2.0 in. per hour	Less than 2.0 in. per hour	More than 2.0 in. per hour
Slope (percent)		0 to 15	15 to 25	More than 25
Soil texture 5/ (dominent to a depth of 60 ins.)		Sandy loams, loam, silt loam, sandy clay loam	Silty clay loam 6/ clay loam, sandy clay, loamy sand	Silty clay, clay, muck, peat, gravel, sand
Depth to bedrock	Hard	More than 72 ins.	More than 72 ins.	Less than 72 ins.
	Rippable	More than 60 ins.	Less than 60 ins.	Less than 60 ins.
Stoniness 7/		0, 1	2	3, 4, 5
Rockiness 7/		0	0	1, 2, 3, 4, 5

1/ Based on soil depth (5-6 ft.) commonly investigated in making soil surveys.
2/ If the probability is high that the soil material to a depth of 10 to 15 feet will not alter a rating of slight or moderate, indicate that by an appropriate footnote such as "Probably slight. to 12 feet," or "Probably moderate to 12 feet."
3/ Soil drainage classes do not correlate exactly with depth to seasonal water table. The overlap of the moderately-well drained soils into two limitation classes allows some of the wetter moderately-well drained soils (mostly in the Northeast) to be given a moderate limitation.
4/ Reflects ability of soil to retard movement of landfill leachate. May not be a factor in arid and semiarid areas,
5/ Reflects ease of digging and moving soil material (workability) and trafficability in the immediate area of the trench that may not have surfaced roads.
6/ Soils high in expanding clays may need to be rated as severe.
7/ Soil Survey Manual. pp. 216-223.

Because routine soil investigations are normally confined to depths of about 5 or 6 feet and many landfill operations use trenches as deep as 15 or more feet, there is need for a geological investigation of the area to determine the potential for pollution of ground water as well as to obtain the design of the sanitary landfill. Such investigations, usually arranged for by the user, include the kind of stratification, rock formations, and the like that can conduct leachate to water sources such as aquifers, wells, and water courses. The presence of hard, nonrippable bedrock, creviced bedrock, sandy or gravelly strata within or immediately underlying the proposed trench bottom is undersirable from the standpoint of excavation and from the standpoint of the potential for pollution of underground water.

The size and character of landfills are such that it would not be practical to remove the refuse if a pollution problcm should develop. Consequently, a thorough evaluation of site hydrology is essential to landfill design.

Sample statements for trench type landfill:

(1) Moderate: Stones.
(2) Severe: Bedrock at 4 feet.

The following explains in more detail some of the criteria used in arriving at the soil limitations for sanitary landfills.

Soil drainage classes and depth to seasonally high water tables Primary consideration in these ratings is the degree and duration of wet soil conditions that make earth moving operations difficult, and the potential for the contamination of ground water.

Permeability This rating applies to the most permeable layer below the A horizon. Soils with slow permeability arc most desirable because they minimize the probability of polluting ground water by either vertical or lateral seepage. Permeable horizons near the bottom of the trench type landfill may be sealed by compacting a blanket of relatively impervious material at least 2 feet thick along the side and bottom of the trench.

Sloping soils More grading is generally required to provide roads to and from landfills located on sloping to steep soil than on more level areas. Also, more care is needed on sloping soils to provide for the proper disposal of surface water from adjacent areas. In the trench type landfill the trench bottom should be kept as nearly level as possible because it tends to act as a seepage plane. The solid waste layer will offer little impedance to the movement of water. Thus sloping trench bottoms are likely to result in difficult problems of seepage in the completed landfill. Trenches should be placed on the contour with the trench bottoms level or nearly so.

Soil Texture The resting for soil texture in the trench type fill is based on the ease of digging the trench and on the ease of using the soil material for the daily and final cover. Soil texture indicates workability which is important because of the need to move material daily during both dry and wet periods. Soils that are plastic and sticky when wet are difficult to excavate, to grade, and to compact. Placing 8 layer of wet clayey soil material of uniform thickness over a cell of refuse is difficult.

The upper part of the final cover should be soil material favorable for growing plants. In most soils the A horizons have the best workability and the highest content of organic matter as compared to horizons lower in the soil. Thus in the landfill operation it is desirable to stockpile the topsoil for use in final blanketing of the landfill.

f. Local roads and streets This guide applies to soils evaluated for construction and maintenance of local roads and streets, Table 6, Page 52. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) Underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime--or soil cement--stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 6 feet. Excluded from consideration in this guide are highways designed for fast moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification, and the shrink-swell potential give an indication of the traffic supporting capacity, Wetness and flooding affect stability. Slope, depth of hard-rock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Soil limitation ratings do not substitute for basic soil data or for onsite investigations.

Sample statements for local roads and streets:

(1) Severe: Poorly drained
(2) Moderate: Occasional flooding

Table 6. Soil Limitation Classes for Local Roads and Streets

Items affecting use	Degree of soil limitation		
	Slight	Moderate	Severe
Soil drainage class 1/	Excessively, somewhat excessively, well, and moderately well	Somewhat poorly	Poorly and very poorly
Flooding	None	Once in 5 years	More than once in 5 years
Slope (percent)	0-8	8-15	More than 15
Depth to bedrock 2/	More than 40 in.	20 to 40 in.	Less than 20 in
Subgrade 3/ a. AASHO Group Index 4/	0 to 4	5 to 8	More than 8
b. Unified soil classes	GW,GP,SW,SP,GM, GC9/, SM,SC9/	CL with PI5/ less than 15 ML	CL with PI5/ 15 or more. CH, MH6/, OH,OL,Pt
Shrink-swell potential	LOW	Moderate	High
Susceptibility to frost heave 7	LOW	Moderate	High
Stoniness 8/	Classes 0, 1, 2	Class 3	Classes 4, 5
Rockiness 8/	Class 0	Class 1	Classes 7, 3, 4, 5

1/ For definitions see Soil Survey Manual, pp. 169-172.

2/ If bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery, reduce moderate and severe limitations by one class.

3/ Use AASHO Group Index values if available from laboratory tests; otherwise, use the estimated Unified classes.

4/ Use Group Index values according to AASHO Designation M 145-49 and M145-66I; for most soils with group index values below about 8, both designations (methods) give results nearly enough alike to be considered alike for the purposes of this guide.

5/ PI means plasticity index.

6/ Upgrade to moderate if MH is largely kaolinitic, friable, and free of mica.

7/ Use this item only where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. See section "Potential Frost Action" for guidance to classes.

8/ For definitions see Soil Survey Manual, pp. 216-223.

9/ Downgrade to moderate content of fines is greater than about 30 percent.

g. Playgrounds This guide sheet applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments. Soil suitability for growing and maintaining vegetation is not a part of this guide but is an important item to consider in final evaluation of a site.

Table 7. Playgrounds

Items Affecting Use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Wetness	Excessive, somewhat excessive, well, & moderately well drained soils. Water table below 30" during season of use	Moderately well & somewhat poorly drained soils. Water table below 20" during season of use.	Somewhat poorly, poorly, & very poorly drained soils. Water table above 20" during season of use.
Flooding	None during season of use.	May flood once in 2 years during season of use.	Floods more than once in 2 years during season of use.
Permeability	Very rapid to moderate, inclusive.	Moderately slow 1/ and slow.	Very slow. 1/
Slope	0-2 percent	2-6 percent	6 percent plus
Surface soil texture 2/	sl,fsl,vfsl,l, sil 3/	cl,scl,sicl,ls 3/	sc,sic,c,organic soils, sand, & loamy sand subject to blowing.
Depth to bedrock	Over 40"	20-40" 4/	Less than 20"
Coarse fragments on surface 5/	Relatively free of fragments.	Up to 20 percent coarse fragments	20 percent plus
Stoniness 5/	Class 0	Classes 1 & 2	Classes, 3, 4, & 5
Rockiness 5/	Class 0	Class 1	Classes 2,3,4, & 5

1/ Soils that are dry for long periods during season of use may be rated one limitation class better.

2/ Surface soil texture influences soil ratings as it affects foot trafficability. surface wetness. dust, and maintenance.

3/ If dust is a problem rate soil one class lower (from slight to moderate or moderate to severe).

4/ May be rated slight on 0-2 percent slopes.

5/ See definitions in Soil Survey Manual, pp. 217-221.

h. camp areas This guide sheet applies to soils to be used intensively for tents and small camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and leveling for tent and parking areas. The soils should be suitable for heavy foot traffic by humans and for limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide but is an item to consider in final evaluation of a site.

Table 8. Camp Areas

Items Affecting Use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Wetness	Excessive, somewhat excessive, well & moderately well drained soils. Water table below 30" during season of use.	Moderately well & somewhat poorly drained soils. Water table below 20" during season of use.	Somewhat poorly, poorly, & very poorly drained soils. Water table above 20" during season of use.
Flooding	None	None during season of use.	Floods during season of use.
Permeability	Very rapid to moderate, inclusive.	Moderately slow & slow 1/.	Very slow. 1/
Slope	0-8 percent	8-15 percent	15 percent plus
Surface soil texture 2/	sl,fsl,vfsl,l, sil 3/	cl,scl,sicl,ls, & sand other than loose sand. 3/	Organic,sc,sic,c, loose sand,& soils subject to severe blowing. 4/
Coarse fragments on surface 5/	0-20 percent	20-50 percent 6/	50 percent plus
Stoniness 5/	Classes 0 & 1	Class 2	Classes 3,4 & 5
Rockiness 5/	None	Classes 1 & 2	Classes 3,4 & 5

1/ Soils that are dry for long periods during season of use may be rated one limitation class better.

2/ Surface soil texture influences soil ratings as it affects trafficability, dust, and soil permeability.

3/ Soils that are dry for long periods such as Aridisols and some soils in xeric great groups may have moderate or severe soil limitations due to a dust problem.

4/ Soils that are dry for long periods such as some fine-textured Aridisols and some fine-textured soils in xeric great groups may have a moderate limitation if dust or mud does not present a severe limitation.

5/ Very shallow soils are rated as having a severe soil limitation. See definition in Soil Survey Manual, pp. 217-221, for rockiness and stoniness.

6/ Some gravelly soils may be rated slight if the content of gravel exceeds 20 percent by only a small margin providing (a) the gravel is imbedded in the soil matrix or (b) the fragments are less than 3/4 inch in size.

i. Picnic Areas This guide sheet applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to access roads. Soil suitability for growing vegetation is not a part of this guide but is an item to consider in final evaluation of a site.

Table 9. Picnic Areas

Items Affecting Use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Wetness	Excessive, somewhat excessive, well, & moderately well drained soils. Water table below 20" during season of use.	Moderately well & somewhat poorly drained soils. Water table during season of use may be less than 20" for short periods.	Poorly & very poorly drained soils. Water table above 20" and often near the surface for a month or more during season of us
Flooding	None during season of use.	May flood 1 or 2 times for short periods during season of use.	Floods more than 2 times during season of use.
Slope	0-8 percent	8-15 percent	15 percent plus
Surface soil texture 1/	sl, fsl, vfsl, l, sil 2/	cl, scl, sicl, ls, & sand other than loose sand. 2/	sc, sic, c, loose sand, organic soils & soils subject to severe blowing. 3/
Coarse fragments on surface 4/	0-20 percent	20-50 percent 5/	50 percent plus
Stoniness 4/	Classes 0, 1, & 2	Class 3	Classes 4 & 5
Rockiness 4/	Classes 0 & 1	Class 2	Classes 3, 4, & 5

1/ Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

2/ Soils that are dry for long periods such as Aridisols and some soils in xeric great groups may have moderate or severe soil limitations due to a dust problem.

3/ Soils that are dry for long periods such as some fine-textured Aridisols and some fine-textured soils in xeric great groups may have a moderate limitation if dust or mud does not present a severe limitation for use as picnic areas.

4/ See definition in Soil Survey Manual, pp. 217-221.

5/ Some gravelly soils may be rated slight if the content of gravel exceeds 20 percent by only a small margin providing (a) the gravel is imbedded in the soil matrix or (b) the fragments are less than 3/4 inch in size.

j. Paths and trails This guide sheet applies to soils to be used for local and cross-country footpaths and trails and for bridle paths. It is assumed that these areas will be used as they occur in nature and that little or no soil will be moved (excavated or filled). Soil features that affect trafficability, dust, design and maintenance of trafficways are given special emphasis in this guide.

Table 10. Paths and Trails

Items Affecting Use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Wetness	Excessive, somewhat excessive, well & moderately well drained soils. Water table below 20" during season of use	Somewhat poorly drained soils. Water table during season of use may be above 20" for short periods.	Poorly & very poorly drained soils. Water table above 20" and often near surface for month or more during season of use.
Flooding	May flood once a year during season of use.	May flood 2 or 3 times during season of use.	Floods more than 3 times during season of use.
Slope	0-15 percent	15-25 percent	25 percent plus
Surface soil texture 1/	sl, fsl, vfsl, l, sil	sicl, scl, cl, ls	sc, sic, c, sand, organic soils 2/
Coarse fragments on surface 3/	0-20 percent	20-50 percent 4/	50 percent plus
Rockiness or stoniness 3/	Classes 0 & 1	Class 2	Classes 3, 4, & 5

1/ Surface texture influences soil ratings as it affects foot trafficability, dust, design, or maintenance of paths and trails.

2/ Some fine-textured soils that are dry for long periods during season of use such as Aridisols and some soils in xeric great groups may have a moderate limitation if dust or mud does not present a severe limitation.

3/ See definitions in Soil Survey Manual, pp. 217-221. Features such as sheer cliffs, slippery rocks, and the like were not considered in developing this guide but may be important items to consider in final evaluation of a site.

4/ Some gravelly soils may be rated slight if the content of gravel exceeds 20 percent by only a small margin providing (a) the gravel is imbedded in the soil matrix or (b) the fragments are less than 3/4 inch in size.

2. Suitability as source of--

a. Road fill The purpose of this interpretation is to provide ratings of soils as sources of road fill. This purpose requires predictions of how well the soil will perform after it has been moved from its original location and placed in a road embankment; and, it also requires evaluation of soil characteristics, such as slope, that effect the ease or difficulty of getting the soil out.

Road fill, Table 11, Page 58, is soil material used for making embankments for roads. As low embankments, or the upper part of high embankments, serve as the subgrade (foundation) for the road, the material good for road fill also needs to be good for subgrade.

In road design and construction, an effort is made to have the volume of material for fills equal, within short distances, the material taken from cuts. Much of the road fill, therefore, comes from nearby cuts if the material is suitable. Where cuts do not yield enough material for local embankments, the fill material is obtained from borrow pits.

As soil survey interpretations are oriented to local roads and streets, rather than to super highways like those of the Interstate System, the assumption is made that the soil is evaluated for rather low embankments, generally less than 6 feet high, that usually are designed with less specificity than high embankments. The assumption also is made that even low embankments are properly constructed, with adequate compaction and provisions for drainage.

Usually the whole soil, from the surface to a depth of 5 or 6 feet, is given one rating on the assumption that the soil horizons will be mixed in loading, dumping, and spreading operations. If the surface layer, from a few inches to as much as about a foot thick is poorly suited, this fact is disregarded in establishing the rating. If the thickness of suitable material is less than about 3 feet, due to shallow depth of bedrock or to other unsuited or poorly suited material, the entire soil is to be rated poor regardless of the quality of the material less than 3 feet thick.

In tables, rating terms usually are accompanied by short phrases setting forth information that is especially helpful to users. For rating of fair and poor, the principal restrictive soil features should be given. Some sample comments are: (1) Fair - stones and boulders; (2) Poor - high shrink-swell potential; (3) Poor - outcrops of bedrock numerous.

b. Sand and gravel The principal purpose of this interpretation is to provide guidance about where to look for sand and gravel. These materials, used in great quantities in many kinds of construction, are bulky, heavy, and expensive to transport. Information, therefore, about where to look for these materials can result in substantial savings.

Table 11. Soil Suitability Classes as Sources of Road Fill

Items affecting use 1/		Soil Suitability Classes		
		Good	Fair	Poor
Engineering soil class	Unified	GW,GP,SW,SP,GC2/, SM2/, SC2/	ML,CL with PI3/ less than 15	CL with PI3/more than 15, CH,MH4/, OL,OH,Pt
	AASHO group index 5/	0 to 4	5 to 8	More than 8
Shrink-swell potential		Low	Moderate	High
Susceptibility to frost action 6/		Low	Moderate	High
Slope (percent)		0 to 15	15 to 25	More than 25
Stoniness class 7/		0, 1, 2	3	4, 5
Rockiness class 7/		0, 1	2	3, 4, 5
Soil drainage class 7/		Excessively to moderately well	Somewhat poorly	Poorly, very poorly

1/ The first three items are predictions about the soil after it is placed in a fill; the last four items pertain to the soil in its natural condition before excavation for road fill.

2/ Downgrade to fair if content of fines is greater than about 30 percent.

3/ PI means plasticity index,

4/ Upgrade to fair if KH is largely kaolinitic, friable, and free of mica.

5/ Use only where laboratory data are available for the kind of soil being rated; otherwise use Unified classes.

6/ Use this item only where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. See section "Potential Frost Action" for guidance to classes.

7/ For definitions see Soil Survey Manual.

Ratings are based on the probability that soils contain sizeable quantities of sand or gravel, excluding soft materials such as shale or siltstone. To quality as either a good or fair probable source, the layer should be at least about 3 feet thick. All of this, however, need not be in the top 5 or 6 feet--the soil that we classify and map. If the approximate lowest 6 inches of this section is sand or gravel, and from observations made in deep cuts and other evidence, including geological, the sand or gravel reached at the bottom of this section is known to extend downward several feet, the thickness requirement is satisfied.

Some soils have little or no sand or gravel in the topmost 5 or 6 feet. Yet, from observations made in deep cuts, and from knowledge of local geology, the fact that some soils are underlain by sand and gravel may be well established. Because of the absence of sand and gravel in the soil that we map and classify, it is rated poor or unsuited; but, by an appropriate footnote, explain that sand and gravel do in fact occur under the soil, and give a short descriptive comment about the material.

The ratings do not reflect quality except in terms of grain size indicated by classes in the Unified soil classification system, These ratings reflect only the general relative quality for many uses, such as aggregate for concrete and filters for drains, but not for some uses such as the wearing surface of unpaved roads.

Table 12 below provides general guidance for determining suitability ratings.

Factors, such as thickness of overburden and location of water table, that may affect the ease or difficulty of mining the materials are not considered in arriving at the ratings. Appropriate comments about such matters, if significant, should be added after the rating terms, as, for example "Good; but high water table."

Whether two columns, one for sand and one for gravel, or just one for both, are used for presenting the ratings in Table 11 depends on the nature of the materials in the survey area. If it has sand but no gravel, simply use one column for sand.

Table 12. Soil Suitability Classes as Sources of Sand and Gravel

	Probable Source		Improbal	Source
	;ood	Fair	Poor	Unsuited
ɔil classes in Unified system	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other classes

c. Topsoil The purpose of this interpretation is to provide information for use by engineers, landscapers, nurserymen, planners, and others who make decisions about selection, stockpiling, and use of topsoil. Whether to save and stockpile surface soil at a construction site, for example, ought to depend on how good it is for topsoil and the relative availability of other topsoil in the immediate vicinity.

Topsoil has several meanings, but in soil survey interpretations it means soil material to spread over barren surfaces, usually made barren by construction, so as to improve soil conditions for re-establishment and maintenance of adapted vegetation; and to improve soil conditions on lawns, gardens, and flower beds where vegetation already may exist.

Good topsoil, Table 13, Page 61, has physical, chemical, and biological characteristics favorable for the establishment and growth of adapted plants. It is friable and easy to handle and spread. While a high content of plant nutrients in good balance is desirable, it is less important than responsiveness to fertilization, and to liming too if pH adjustments are necessary.

A soil that qualifies as a good source not only has material with these favorable characteristics, but also has characteristics such that, with material stripped off for topsoil, the remaining soil is reclaimable. Some damage to a borrow area is to be expected, but if the damage is great enough so that revegetation and erosion control become major problems, the soil should be rated as a poor source of topsoil regardless of the quality of the surface materials. This constraint does not apply to construction sites where the soils are drastically disturbed in the construction process; and topsoil ratings of soils for such places therefore may be different. Unless otherwise specified, however, the assumption is made that localities from which topsoil is taken are to be restored.

Also considered in rating soil as a source of topsoil are certain features that affect the ease or difficulty of excavating the material, particularly the soil slope, wetness, and thickness of the material that is suitable.

Usually, only the surface layer is rated; but, if this is less than about 8 inches thick, assume that it will be mixed with the adjacent layer to make up a thickness of at least 8 inches and rate this mixture. If the subsoil is better than the surface soil, give a second rating and indicate that it is for the subsoil between 8 and 30 inches or whatever the limits are for the specific soil.

Table 1.3. Soil Suitability Classes as Source of Topsoil

Item	Degree of Soil Suitability		
	Good	Fair	Poor
Moist consistence	Very friable, friable	Loose, firm	Very firm, extremely firm
Texture	fsl,vfsl,l,sil,sl; sc if 1:1 clay is dominant	cl,scl;sicl;sc if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	s,ls; c and sic if 2:1 clay is dominant. Organic soils.
Thickness of material (usually top part of profile)	More than 16 in.	8 to 16 in.	Less than 8 in.
Coarse fragments (Percent) by volume	Less than 3	3 to 15	More than 15
Soluble salts; conductivity of saturation extract mmhos cm	Less than 4	4 to 8	More than 8
Surface stoniness 1/	Class 0	Class 1	Classes 2,3,4,5
Slope (percent)	Less than 8	8 to 15	More than 15
Drainage class 1	Drainage class not determining if better than poorly drained		Poorly drained, very poorly drained

1/ For definitions see Soil Survey Manual.

Severeal items that affect suitability of some soils are not treated in Table 13. If a soil contains toxic substances, it should be rated as poor, and also if it contains sulfides which themselves might not be toxic but which, upon aeration induce a very low pH. Soils with rock outcrops spaced and arranged so as to make excavation difficult or impractical should be rated poor even though the soil between the outcrops may be satisfactory. Some soils, such as Andepts, for which the real texture cannot be determined with confidence, should be rated to the extent possible by comparing their relative suitability with soils that can be rated by Table 13.

The ratings of fair or poor in the table on engineering interpretations usually should be followed by a brief comment giving the principal one or two restrictive characteristics. Some sample comments are: (1) Fair - slopes 10 to 20 percent; (2) Poor-- high water table; (3) Poor - to depth of 8 inches, Fair - to depth of 30 inches; (It) Poor - contains sulfides.

VII. GLOSSARY OF TERMINOLOGY

Aggregate, soil   Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium   Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Andesite   A volcanic rock composed essentially of andesine and one or more mafic constituents.

Aquifer - A geologic formation or structure that transmits water in sufficient quantity to supply the needs for a water development. Aquifers are usually saturated sands, gravel, fractures, cavernous and vesicular rock.

Argillite - An argillite is defined as a rock derived either from siltstone, claystone, or shale, that has undergone a somewhat higher degree of induration than is present in those rocks,

Arkose - The arkose is a rock of granular texture, formed principally by process of mechanical aggregation. It is essentially composed of large grains of clear quartz and grains of feldspar, either lamellar or compact, or like clay.

Ash, volcanic - Uncemented pyroclastic material consisting of fragments mostly under 4 mm. in diameter.

Association, soil - A group os soils geographically associated in a characteristic repeating pattern.

Available water capacity - The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Badlands - A land type consisting of steep or very steep barren land, usually broken by an intricate maze of narrow ravines, sharp crests, and pinnacles resulting from serious erosion of soft geologic materials.

Basalt - An extrusive rock composed primarily of calcic plagioclase, pyroxene, with or without olivine.

Basic Rock - A term rather loosely used in lithology to mean generally one of the following: (a) An igneous rock containing 45

Caliche - A layer near the surface, more or less cemented by secondary carbonates of calcium or magnesium precipitated from the soil solution. The materiel may consist of soft, thin layers in the soil or of herd, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Capability Classification, land - A grouping of kinds of soil into special. units, subclasses, and classes according to their capability for intensive use and the treatments required for sustained use, prepared by the Soil Conservation Service, USDA.

Capillary, water - The water held in the "capillary" or small pores of a soil, usually with tension greeter then 60 centimeters of water.

Cementation - The process of precipitation of a binding materiel around grains or minerals in rocks.

Chalk - A very soft, white to light gray, unindureted limestone composed of the tests of floating microorganisms end some bottom dwelling forms (ammonoids and pelecypods) in a matrix of finely crystalline calcite; some chalk may be almost devoid of organic remains.

Chert - Cryptocrystalline varieties of silica regardless of color, composed mainly of petrographically microscopic chalcedony and/or quarts aarticles whose outlines range from easily resolvable to nonresolvable with binocular microscope at magnifications ordinarily used. Particles rarely exceed 0.5 mm in diameter.

Clay-pan - A dense, compact layer in the subsoil having a much higher clay content then the overlying materiel from which it is separated by a sharply defined boundary; formed by downward movement of clay or by synthesis of clay in place during soil formation. Clay-pans are usually herd when dry and plastic and sticky when wet.

Coastal Plain - Broad low plains between mountain ranges end the seashores.

Colloid, soil - Collid refers to organic or inorganic matter having very small particle size and a correspondingly large surface area per unit of mass. Most colloidal particles ere too small to be seen with the ordinary compound microscope.

Colluvium - A general term spplied to loose and incoherent deposits, usually at the foot of a slope or cliff end brought there chiefly by gravity.

Complex, soil - A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a published soil mep.

Concretions - A local concentration of a chemical compound, such as calcium carbonate or iron oxide, in the form of an aggregate or nodule of varying size, shape, hardness, and color.

Consolidated - Any or all of the processes whereby loose, soft, or liquid earth materiels become firm and hard.

Coulee - A French term for lava flow.

Diatomaceous Earth - A friable earthy deposit composed of nearly pure silica and consisting essentially of the frustules of the microscopic plants celled diatoms.

Drainage, soil - As a natural condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation.

Drainage Class, soil - The relative terms used to describe natural drainage.

Drift, glacial - Rock debris transported by glaciers and deposited either directly from the ice or from the meltwater. The debris may or may not be heterogenous.

Dune - By geological writers, this work is used to signify a low hill, or bank, of drifted sand, and in no respect is synonymous with down, as might be inferred from Todd and Webster.

Eluviation - The removal of soil material in suspension (or in solution) from a layer or layers of a soil.

Eolian soil material - Soil material accumulated through wind action.

Erodibility - Capabie of being eroded.

Escarpment - A steep face or a ridge of high land; the escarpment of a mountain range is generally on that side nearest the sea,

Floodplain - Nearly level land situated on either side of a channel which is subject to overflow flooding.

Fragipan - A natural subsurface horizon with high bulk density relative to the solum above, seemingly cemented when dry but showing a moderate to weak brittleness when moist.

Genesis, soil - The manner in which a soil originated, with special reference to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice.

Gneiss - A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.

Granite - A plutonic rock consisting essentially of alkalic feldspar and quartz.

Gravitational water - Water that moves into, through, or out of the soil under the influence of gravity.

Hardpan A hardened soil layer in the lower A or in the B horizon caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides, or calcium carbonate.

Humus - That more or less stable fraction of the soil organic matter remaining after the major portion of added plant and animal residues have

Infiltration rate - A soil characteristic determining or describing the maximum rate at which water can enter the soil under specified conditions, including the presence of an excess of water.

Inherited Characteristics of soils - Those characteristics of soils that are due to the parent material that the soils formed in.

Internal Soil Drainage - The downward movement of water through the soil profile.

Kaolinite - Hydrous aluminum silicate clay mineral of the 1:1 crystal lattice group, that is, consisting of one silicon tetrahedral layer and one aluminum oxide-hydroxide octahedral layer.

Lacustrine - Produced by or belonging to lakes.

Leaching - The removal of materials in solution from the soil.

Limestone - A sedimentary rock composed of calcium carbonate, $CaCo_3$.

Loess - Material transported and deposited by wind and consisting of predominantly silt-sized particles.

Made land - Areas filled with earth or earth and trash mixed, usually made by or under the control of man.

Marine Material - Material deposited in the ocean and later exposed to the soil forming processes.

Marl - A calcareous clay, or intimate mixture of clay and particles Of calcite or dolomite, usually fragments of shells.

Microclimate - The detailed climate of a very small area of the earth's surface, e.g., a single forest..., over which small variations exist from place to place, differing from the general climate of the surrounding region,

Microrelief - Minor differences in surface configuration of the land surface.

Mineral - A homogeneous naturally occuring phase; by some authorities restricted to inorganic, crystalline phases.

Mineral, soil - A soil consisting predominantly of, and having its properties determined predominantly by, mineral matter, usually containing less than 20 percent organic matter but sometimes containing an organic surface layer up to 30 centimeters thick.

Montmorillonite - A hydrous, aluminosilicate clay mineral with 2:1 expanding crystal lattice, that is, with two silicon tetrahedral layers enclosing an aluminum octahedral layer.

Morphology, soil - The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottled - Soil horizons irregularly marked with spots of color.

Muck - Highly decomposed organic material in which the original plant -parts are not recognizable.

Organic Matter - The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

Organic Soil - A soil that contains a high percentage (greater than 20 or 30 percent) of organic matter in the solum.

Ortstein - The organic and sesquioxide cemented subsoil layer in podzols or groundwater podzols. It does not soften appreciably when immersed in water.

Outwash - Stratified drift deposited by meltwater streams beyond active glacier ice.

parent Material - The unconsolidated, chemically weathered mineral or organic matter from which the solum of soils has developed by pedogenci processes.

Peat - Unconsolidated soil material consisting largely of undecomposed or only slightly decomposed organic matter accumulated under conditions of excessive moisture.

Ped - A unit of soil structure, such as an aggregate, crumb, prism, block, or granule, formed by natural processes.

Pedology - The science which treats of soils, their Origin, character and utilization.

Perched Water Table - The surface of a local zone of saturation held above the main body of groundwater by an impermeable layer or stratum, usually clay, and separated from the main body of groundwater by an unsaturated zone.

Percolation - Movement, under hydrostatic pressure of water through the interstices of the rock or soil, except movement through large openings such as caves.

Permeability, soil - The quality of a soil horizon that enables water or air to move through it.

Porosity - The degree to which the total volume of a soil, sediment, or rock is permeated with pores or cavities, generally expressed as a percentage of the whole volume unoccupied by solid particles.

Pumice - An excessively cellular, glassy lava, generally of the composition of rhyolite.

Quartz - A mineral, SiO_2.

Recent Soil - A soil formed since the close of the Glacial epoch until and including the present.

Regolith - The layer or mantle of loose, noncohesive or cohesive rock material, of whatever origin, that nearly everywhere forms the surface of the land and rests on bedrock,

Relief - The elevations or the inequalities, collectively, of a land surface.

Residual Material - Unconsolidated and partly weathered mineral materials accumulated by disintegration of consolidated rock in place.

Rhyolitc - The extrusive equivalent of a granite.

Runoff - The water which flows on the surface is called the runoff though this term is used to include also the water which returns to the surface after a greater or less underground passage.

Saline, soil - A nonalkali soil containing sufficient soluble salts to impair its productivity but not containing excessive exchangeable sodium.

Sandstone - A cemented or otherwise compacted detrital. sediment composed predominantly of quartz grains, the grades of the latter being those of sand.

Schist - A synonym for Slate.

Sedimentary rocks - Formed by lithification of sediments, mechanical, chemical, or organic.

Separate, soil - Mineral particles, less than 2.0 millimeters in equivalent diameter, ranging between specified size limits.

Series, soil - The systematic arrangement of soils into classes in one or more categories or levels of classification for a specific object.

Sesquioxide - Refers to iron and aluminum oxides.

Shale - A laminated sediment, in which the constituent particles are predominantly of the clay grade.

Shot - The explosion in seismic operations.

Site Condition - An engineering term--refers to slope, drainage, soil material. These are things that can be altered during construction.

Slate - A fine-grained metamorphic rock possessing a well-developed fissility (slaty cleavage).

Slick Spots - Small areas in a field that are slick when wet due to a high content of alkali or exchangeable sodium.

Slope, soil - Refers to the incline of the surface of the soil area. It is an integral part of any soil as a natural body.

Soil Quality - Soil qualities are those qualities inferred from observed features of the soil.

Soil Property - Features of the soil that can be seen and/or measured.

Solum - The upper part of a soil profile, above the parent material, in which the processes of soil formation are active.

Stratified - Formed or lying in beds, layers, or strata.

Subsoil - The B horizons of soils with distinct profiles.

Substratum - Any layer lying beneath the soil solum, either conforming (CR) or unconforming.

Subsurface, soil - Generally refers to the A2 horizon. This horizon is the horizon of maximum leaching.

Surface, soil - The uppermost part of the soil ordinarily moved in tillage or its equivalent in uncultivated soils, ranging in depth from about 5 to 8 inches.

Talus - Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

Terrace - An embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Texture, soil - The relative proportions of the various soil separates in a soil as described by the classes of soil texture.

Till, glacial - Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Transported Soil Material - Carried by wind, glaciers, gravity, or Water from its former site.

Truncated soil profile - Soil profile that has been cut down by accelerated erosion or by mechanical means.

Upland - A highland; ground elevated above the lowlands along rivers or between hills.

Valley - Any hollow or low-lying land bounded by hill or mountain ranges; and usually traversed by a stream or river which receives the drainage of the surrounding heights.

Volcanic - Of, pertaining to, like, or characteristic of, a volcano.

Water Table - The upper surface of a zone of saturation except where that surface is formed by an impermeable body.

Weathering - The group of processes, such as the chemical action of air and rain water and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

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IX. APPENDIX

A. UNIFIED SOIL CLASSIFICATION

FIELD IDENTIFICATION

FIELD IDENTIFICATION PROCEDURES

COARSE GRAINED SOILS More than half of material (by weight) is of individual grains visible to the naked eye. No. 200 sieve size is about the smallest particle visible to the naked eye.	GRAVEL AND GRAVELLY SOILS More than half of Coarse Fraction (by weight) is larger than ¼ in. size. For visual classification the ¼ in. size may be used as equivalent to the No. 4 sieve size.	CLEAN GRAVELS Will not leave a dirt stain on a wet palm.	Wide range in grain sizes and substantial amount of all intermediate particle sizes.
			Predominantly one size or a range of sizes with some intermediate sizes missing.
		DIRTY GRAVELS Will leave a dirt stain on a wet palm.	Nonplastic fines or fines with low plasticity (for identification of fines see characteristics of ML below).
			Plastic fines (for identification of fines see characteristics of CL below).
	SAND AND SANDY SOILS More than half of Coarse Fraction (by weight) is smaller than ¼ in. size.	CLEAN SANDS Will not leave a dirt stain on a wet palm.	Wide range in grain size and substantial amounts of all intermediate particle sizes.
			Predominantly one size or a range of sizes with some intermediate sizes missing.
		DIRTY SANDS Will leave a dirt stain on a wet palm.	Nonplastic fines or fines with low plasticity (for identification of fines see characteristics of ML below).
			Plastic fines (for identification of fines see characteristics of CL below).

		ODOR	DRY CRUSHING STRENGTH	DILATANCY (SHAKE) REACTION	TOUGHNESS	RIBBON (NEAR THE P.L.)	SHINE (NEAR THE P.L.)
FINE GRAINED SOILS More than half of material (by weight) is of individual grains not visible to the naked eye. No. 200 sieve size is about the smallest particle visible to the naked eye.	SILTS AND CLAYS (Low Plastic) See Identification Procedures		Slight	Rapid	Low to None	None	Dull
			High	Medium to Slow	Medium	Weak	Slight to Shiny
		Pro-nounced	Medium	Slow to None	Low	None	Dull to Slight
	SILTS AND CLAYS (Highly Plastic)		Medium	Very Slow to None	Medium	Weak	Slight
			Very High	None	High	Strong	Shiny
		Pro-nounced	High	None	Low to Medium	Weak	Dull to Slight
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.					

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FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Calcium carbonate or iron oxides may cause higher dry strength in dried material. If acid causes a fizzing reaction, calcium carbonate is present.

Dilatency (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Toughness (Consistency near plastic limit)

After removing particles larger than No. 40 sieve size, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms, into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Non-plastic soils cannot be rolled into a thread at any moisture content.

The toughness increases with the P.I.

INFORMATION REQUIRED DURING LOGGING

COARSE GRAINED SOILS

For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristic

Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.

Example:
Silty sand, gravelly; about 20% hard, angular gravel particles ½ in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).

FINE GRAINED SOILS

ORGANIC SOILS

Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any local or geologic name, and other pertinent descriptive information; and symbol in parentheses.

For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.

Example:
Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).

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TYPICAL NAMES	IMPORTANT PROPERTIES					
	SHEAR STRENGTH	COMPRESS-IBILITY	WORKABILITY AS CONSTRUCTION MATERIAL	PERMEABILITY WHEN COMPACTED	K CM. PER SEC.	K FT. PER DAY
Well graded gravels, gravel-sand mixtures, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-2}$	$K > 30$
Poorly graded gravels, gravel-sand mixtures, little or no fines.	Good	Negligible	Good	Very Pervious	$K > 10^{-2}$	$K > 30$
Silty gravels, gravel-sand-silt mixtures.	Good to Fair	Negligible	Good	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}
Clayey gravels, gravel-sand-clay mixtures.	Good to Fair	Very Low to Low	Good	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}
Well graded sands, gravelly sands, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-3}$	$K > 3$
Poorly graded sands, gravelly sands, little or no fines.	Good to Poor	Very Low	Fair	Pervious	$K > 10^{-3}$	$K > 3$
Silty sands, sand-silt mixtures	Good to Fair	Low	Fair	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}
Clayey sands, sand-clay mixtures.	Good to Fair	Low	Good	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}
Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Fair	Medium to High	Fair	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}
Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Fair	Medium to High	Good to Fair	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}
Organic silts and organic silty clays of low plasticity.	Poor	Medium to High	Fair	Semi-Pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-1}$ to 3×10^{-3}
Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Fair to Poor	High	Poor	Semi-Pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-1}$ to 3×10^{-3}
Inorganic clays of high plasticity, fat clays.	Fair to Poor	High to Very High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}
Organic clays of medium to high plasticity, organic silts.	Poor	High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}
Peat and other highly organic soils.	NOT SUITABLE FOR CONSTRUCTION					

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EMBANKMENTS

COMPACTION CHARACTER-ISTICS	STANDARD PROCTER UNIT DENSITY LBS. PER CU. FT.	TYPE OF ROLLER DESIRABLE	RELATIVE CHARACTERISTICS PERME-ABILITY	COMPRESS-IBILITY	RESISTANCE TO PIPING	ABILITY TO TAKE PLASTIC DEFORMATION UNDER LOAD WITHOUT SHEARING	GENERAL DESCRIPTION & USE
Good	125-135	crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Very stable, pervious shells of dikes and dams.
Good	115-125	crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Reasonably stable, pervious shells of dikes and dams.
Good with close control	120-135	rubber-tired or sheepsfoot	Medium	Slight	Poor to Good	Poor	Reasonably stable, not well suited to shells but may be used for impervious cores or blankets.
Good	115-130	sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, may be used for impervious core.
Good	110-130	crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair	None	Very stable, pervious sections, slope protection required.
Good	100-120	crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair to Poor	None	Reasonably stable, may be used in dike with flat slopes.
Good with close control	110-125	rubber-tired or sheepsfoot	Medium	Slight	Poor to Very Poor	Poor	Fairly stable, not well suited to shells, but may be used for impervious cores or dikes.
Good	105-125	sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, use for impervious core for flood control structures.
Good to Poor Close control essential	95-120	sheepsfoot	Medium	Medium	Poor to Very Poor	*Very Poor	Poor stability, may be used for embankments with proper control. *Varies with water content.
Fair to Good	95-120	sheepsfoot	Low	Medium	Good to Fair	Good to Poor	Stable, impervious cores and blankets.
Fair to Poor	80-100	sheepsfoot	Medium to Low	Medium to High	Good to Poor	Fair	Not suitable for embankments.
Poor to Very Poor	70-95	sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Poor stability, core of hydraulic fill dam, not desirable in rolled fill construction.
Fair to Poor	75-105	sheepsfoot	Low	High	Excellent	Excellent	Fair stability with flat slopes, thin cores, blankets & dike sections.
Poor to Very Poor	65-100	sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Not suitable for embankments.

DO NOT USE FOR EMBANKMENT CONSTRUCTION

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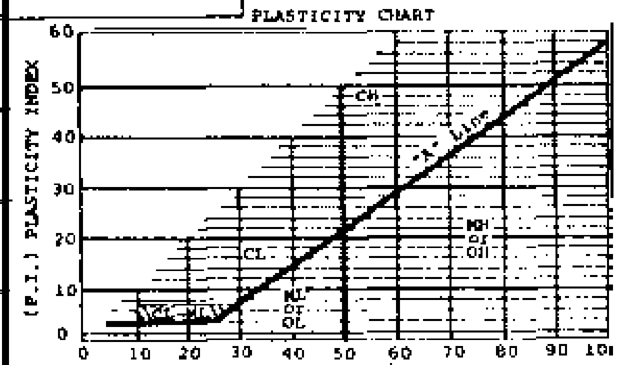
CHANNELS		FOUNDATION				
LONG DURATION TO CONSTANT FLOWS.		FOUNDATION SOILS, BEING UNDISTURBED, ARE INFLUENCED TO A GREAT DEGREE BY THEIR GEOLOGIC ORIGIN. JUDGEMENT AND TESTING MUST BE USED IN ADDITION TO THESE GENERALIZATIONS.				
RELATIVE DESIRABILITY			RELATIVE DESIRABILITY		REQUIREMENTS FOR SEEPAGE CONTROL	
EROSION RESISTANCE	COMPACTED EARTH LINING	BEARING VALUE	SEEPAGE IMPORTANT	SEEPAGE NOT IMPORTANT	PERMANENT RESERVOIR	FLOODWATER RETARDING
1	-	Good	-	1	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.
2	-	Good	-	3	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.
4	4	Good	2	4	Core trench to none	None
3	1	Good	1	6	None	None
6	-	Good	-	2	Positive cutoff or upstream blanket & toe drains or wells.	Control only within volume acceptable plus pressure relief if required.
7 if gravelly	-	Good to Poor depending upon density	-	5	Positive cutoff or upstream blanket & toe drains or wells.	Control only within volume acceptable plus pressure relief if required
8 if gravelly	5 erosion critical	Good to Poor depending upon density	4	7	Upstream blanket & toe drains or wells	Sufficient control to prevent dangerous seepage piping.
5	2	Good to Poor	3	8	None	None
-	6 erosion critical	Very Poor, susceptible to liquefication	6, if saturated or pre-wetted	9	Positive cutoff or upstream blanket & toe drains or wells.	Sufficient control to prevent dangerous seepage piping.

LABORATORY CRITERIA

Major division	Subdivision	Fines	Borderline	Criteria		Group symbol
COARSE-GRAINED SOILS Less than half of material passes the No. 200 sieve size.	GRAVELS Less than half of the coarse fraction passes the No. 4 sieve size.	CLEAN GRAVELS Less than 5% passing the No. 200 sieve size.	Borderline cases require the use of dual symbols.	WELL GRADED Meets gradation requirements	GRADATION REQUIREMENTS ARE: $C_u = \frac{D_{60}}{D_{10}} > 4$ and, $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ < between 1 & 3	GW
				POORLY GRADED Does not meet gradation requirements		GP
		GRAVELS WITH FINES More than 12% passing the No. 200 sieve size.		Plasticity limits of material passing No. 40 sieve size plots below "A" line and P.I. less than 4.	Plasticity limits above "A" line with P.I. between 4 and 7 are border-line cases and require use of dual symbols	GM
				Plasticity limits of material passing No. 40 sieve size plots above "A" line or P.I. more than 7.		GC
	SANDS More than half of the coarse fraction passes the No. 4 sieve size.	CLEAN SANDS Less than 5% passing the No. 200 sieve size.	Borderline cases require the use of dual symbols.	WELL GRADED Meets gradation requirements	GRADATION REQUIREMENTS ARE: $C_u = \frac{D_{60}}{D_{10}} > 6$ and, $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ < between 1 & 3	SW
				POORLY GRADED Does not meet gradation requirements		SP
		SANDS WITH FINES More than 12% passing the No. 200 sieve size.		Plasticity limits of material passing No. 40 sieve size plots below "A" line and P.I. less than 4.	Plasticity limits above "A" line with P.I. between 4 and 7 are border-line cases and require use of dual symbols	SM
				Plasticity limits of material passing No. 40 sieve size plots above "A" line or P.I. more than 7.		SC
FINE-GRAINED SOILS More than half of material passes the No. 200 sieve size.	SILTS AND CLAYS Liquid limit less than 50	Below "A" line and P.I. less than 4		Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols		ML
		Above "A" line or P.I. more than 7				CL
		Below "A" line and P.I. less than 4 and $\frac{\text{L.L. (oven dry soil)}}{\text{L.L. (air dry soil)}} < 0.7$		PLASTICITY CHART		OL
	SILTS AND CLAYS Liquid limit greater than 50	Below "A" line				MH
		Above "A" line				CH
		Below "A" line and $\frac{\text{L.L. (oven dry soil)}}{\text{L.L. (air dry soil)}} < 0.7$				OH
HIGHLY ORGANIC SOILS				$\frac{\text{L.L. (oven dry soil)}}{\text{L.L. (air dry soil)}} < 0.7$		Pt

PLASTICITY CHART



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(1)
(2)
(3)
(4)
[illegible]

(6) Difficulty of growing needed plants.
(7) Siltation of channels, including accumulation from soil blowing.
(8) Available water capacity of soil.
(9) Presence of seepage areas.

Sample statements:
(1) Highly erodible; low available water capacity; low fertility.
(2) Shallow to sand and gravel.
(3) Dense clayey subsoil; seepy areas.
(4) Cuts may expose dense clayey material; high runoff rate.
(5) Subject to accumulations of wind-blowing materials.
(6) Steep slopes; rocks throughout soil profile.

3. Winter grading The suitability of the soils for winter grading depends upon the ease with which the soil can be moved and traversed by ordinary construction equipment during cold weather.

Factors affecting winter grading:
(1) Trafficability (soil texture, slope, stones, wetness).
(2) Depth to water table and soil drainage.
(3) Ease of excavation and compaction (depends on normal moisture content and soil texture).
(4) Susceptibility to forming large frozen clods.
(5) Plasticity (kind and amount of clay).

Sample statements:
(1) Low stability on freezing and thawing.
(2) High water table during winter months; poor surface drainage.
(3) Soils plastic when wet; difficult to excavate.
(4) Difficult to break frozen clods and compact the material.

4. Potential frost action Interpretations of potential frost action, while not routinely made, may be needed where substantial freezing occurs.

Potential frost action, as used in engineering, means the potential effects on structures resulting from freezing, and subsequent thawing, of soil materials. Such action is related mainly to highways and runways, but it may be important to any structure supported or abutted by soil that freezes. Such action pertains not only to heaving as freezing progresses but also to excessive wetting and loss of soil strength upon thawing.

Damage to structures, such as highways, from frost action results not from the freezing of soil itself, but from the formation of ice lenses in the soil. This, in turn, depends upon the soil's capability for delivering water to a stationary or slowly moving freezing front. Almost every soil with more than 3 percent of material smaller than 0.02 mm. has this capability to some extent. Nearly clay-free soils high in silt (0.05-0.002 mm.) and very fine send (0.10-0.05 mm,) have this capability to the greatest degree and, hence, have the greatest potential for frost action; but other soils, if they have a large capillary water capacity, will have a high potential too.

Where frost action is important and interpretations are made, three classes of potential frost action are proposed. These, for lack of better guidance are related to USDA soil texture and to classes in the Unified Soil Classification System. This guidance should be used with the understanding that the best evidence derives from observations made in the field and related to soils as classified and mapped in our soil surveys. While grain size obviously is important, it is not the only property which influences frost action. Other properties such as soil structure and porosity that effect capillary conductivity, and the scarcity or abundance of soil moisture during freezing weather should be considered too. The three classes in terms of texture are:

Low	Moderate	High
sand	clay	silt
loamy sand	silty clay	silt loam
coarse sandy loam	(medium) sandy loam	silty clay loam
	sandy clay loam	loam
	sandy clay	clay loam
		very fine sandy loam
		fine sandy loam

Gravels and other coarse fragments in soils tend to reduce potential frost action, particularly if the content of such materials is high.

In terms of the engineering Unified soil classification system, the three classes are:

Low	Moderate	High
GW	GM	ML
GP	GC	CL
SW	SC	OL
SP	CH	MH
	OH	SM

As classes in the USDA soil texture system and the Unified Soil Classification System cannot be equated exactly, some soils on basis of one system may rate differently than on the basis of the other. In such situations, make a judgment on the basis of the explanation in the preceding paragraphs about which rating seems more appropriate.

5. Piping in undisturbed soils   Soil piping is a kind of subsurface erosion which results in the formation of tunnel-like cavities. The existence of such cavities, or the susceptibility to their formation, can be, and frequently is, a limitation or hazard to structures, such as roads, erosion-control terraces, and canals, built on susceptible soils.

Soil piping in this discussion pertains to soils undisturbed except for the surface 6 to 12 inches or so in tillage or other operations that leave the subsoil and substratum undisturbed. It does not pertain to piping in earth fill dams or other structures to which the soil is moved, and manipulated according to construction specifications.

Not enough is known yet to establish limitation or hazard classes for nationwide use; but, where piping occurs, this fact should be reported in the text part of the engineering interpretation section of published soil surveys.

Salinity Ratings 1	Salinity as Millimhos per cm
None	Less than 2.0
LOW	2.0 to 4.0
Moderate	4.0 to 0.0
High	8.0 to 16.0
Very High	More than 16.0

This column should be omitted if salinity is not, significant to th:: engineering practices of the survey area or if minor in nature and covered by a general statement in the narrative section.

In some soils the presence of layers of' gypsum may present a problem to engineering practices. This should be covered by a separate column or by a footnote.

7. Shrink-swell potential Shrink-swell behavior is that quality of the soil that determines its volume change with change in moisture content. Building foundations, roads, and other structures may be severely damaged by the shrinking and swelling of soils. The volume change of soils is influenced by the amount of moisture change and amount and kind of clay in the soil. Knowledge of the kind and distribution of clay helps to predict the behavior of the soil.

Methods for determining the shrink-swell behavior of soils are both quantitative and qualitative. The quantitative methods are (1) the coefficient of linear extensibility (COLE) used by soil scientists 2/ 3/, and (2) the Potential Volume Change used by Federal Housing Administration 4/.

COLE is an estimate of the vertical component of' swelling of a natural soil clod. COLE is defined as $\frac{Lm-Ld}{Ld}$ where Lm is length of moist sample and Ld length of dry sample. Bulk density is determined for a natural soil clod and volume changes measured at different moisture contents. Since volumes rather than length are measured COLE is calculated:

$$COLE = \left[\frac{Dbd}{Dbm}\right]^{1/3} - 1$$

where Dbd = dry bulk density of< 2 mm fabric.
where Dbm = moist bulk density (field capacity) of < 2 mm fabric.

1/ Ratings adapted from information contained in Agriculture Handbook 60, USDA, 1954.

2/ Grossman, Brasher, Franzmeier, Walker. "Linear Extensibility as Calculated from Natural-Clod Bulk Density Measurements," "Soil Science Society of America Proceedings," Vol. 32, No. 4, July-August 1968, pp. 570-573.

3/ Franzmeier and Ross. "Soil Swelling: Laboratory Measurement and Relation to Other Soil Properties," "Soil Science Society of America Proceedings," Vol. 32, No. 4, July-August 1968, pp. 573-577.

4/ "Soil PVC Meter," a technical studies report, FHA 701, Federal Housing Administration, Washington, D. C., December 1960.

Instead of coefficient of linear extensibility (COLE), some laboratory reports may show linear extensibility (LE) expressed as percentages (LEP). To convert LE to COLE,

Karro	(ML)
Kenyon	(CL)
Norfolk	(SC)
Nunda	(CL)
Maury	(MH)
Scantic	(ML-CL)
	(CL)

Darwin	(CH)
Dayton	(CH)
Edina	(CH)
Houston	(CH)
Iredell	(CH)
Seymour	(CH)
Susquehanna	(CH)
Willows	(CH)

8. Corrosivity Various metals and concrete, corrode when on or in the soil; and, a given material will corrode in contact with some soils more rapidly than in contact with others. Soil corrosivity differs with the general character of the soil. To be meaningful, corrosivity must be given in relation to a specific structural material, and guidance is given here for two materials. Do not use the more general term "metal" in lieu of " uncoated steel", and do not extend interpretations based on criteria for uncoated steel to other kinds of materials, such as cast iron, even though they are made up principally of iron.

Uncoated steel Corrosion of uncoated steel pipe is a physical-biochemical process converting iron into its ions. Soil moisture is needed to form solutions with soluble salts before the process can operate. This constitutes a corrosion cell. Any factors influencing the soil solution or the oxidation-reduction reactions taking place in the soil will influence the operation of the corrosion cell. Some of these factors are soil moisture content, conductivity of soil solution, hydrogen ion activity of soil solutions (pH), oxygen concentration (aeration), and activity of organisms capable of causing oxidation-reduction reactions. The corrosidty of soil for untreated steel pipe is commonly estimated by (1) electrical resistivity or resistance to flow of current, (2) total acidity 1/, (3) soil drainage, and (4) soil texture.

Thr criteria are based on available data, particularly Circular 579, "Underground Corrosion," Department of Commerce, National Bureau of Standards. Table 99, page 167, of this circular is the principal source for criteria1 on resistivity and total acidity. The criteria for conductivity of saturation extract were provided by the SCS Soil Survey Laboratory at Lincoln, Nebraska.

Three classes of low, moderate, and high normally will be used; but five classes can bc used if knowledge of soil corrosivity warrants and five classes are needed for the interpretations. Criteria for five classes are given; but if only three arc used, the classes of low and very low are to be combined and called low, and the classes of high and very high are to be combined and called high.

1/ Total acidity is roughly equal to extractable acidity (Method 6H1a, SSIR No. 1) as determined by Soil Survey laboratories.

very low Somewhat excessive to excessively drained coarse-textured soils with little clay in the control section of the soil. Water and air move through the soil rapidly and very rapidly. The total acidity is below 4.0 meq. per 100 g. of soil or electrical resistivity of' the soil at moisture equivalent1/ is above 10,000 ohm-cm. at 60 F. or electrical conductivity of the saturation extract (Method 9A1, SSIR No. 1) is less than 0.1 mmhos per cm. at 25° C2/ (Noncorrosive).

LOW Well drained soils with moderately coarse- and medium-textured control sections. Somewhat poorly drained soils with coarse-textured control sections, The soils are moderately to rapidly permeable. The total acidity ranges from 4.0 to 8.0 meq. per 100 g. of soil or electrical resistivity at moisture equivalent is 5,000 to 10,000 ohm-cm. at 60° F. or electrical conductivity of the saturation extract is 0.1 to 0.2 mmhos per cm. at 25° C. (Slightly corrosive).

Moderate Well drained soils with moderately fine-textured control sections; moderately well drained soils with medium-textured control section. Also included are somewhat poorly drained soils with moderately coarse-textured control sections. Where the water table remains at the surface throughout the year, very poorly drained soils, including peats and mucks, are included. Permeability is moderately slow to slow. The total acidity ranges from 8.0 to 12.0 meq. per 100 g. of soil or electrical resistivity at moisture equivalent is 2,000 to 5,000 ohm-cm. at 60° F. or electrical conductivity of the saturation extract is 0.2 to 0.4 mmhos per cm. at 25°C. (Moderately corrosive).

High Well and moderately well drained fine-textured soils; moderately well drained, moderately fine-textured soils; somewhat poorly drained soils with medium and moderately fine-textured control sections; or poorly drained soils with coarse to moderately fine-textured control sections. Very poorly drained soils are included where the water table fluctuates within one foot of the surface sometime during the year. The total acidity ranges from 12.0 to 16 meq. per 100 g. of soil or electrical resistivity at moisture equivalent is 1,000 to 2,000 ohm-cm. at 60° F. or electrical conductivity of the saturation extract is 0.4 to 1.0 mmhos per cm. at 25° C. (Severely corrosive).

1/ Moisture equivalent approximates field capacity. Resistivity of fine and medium-textured soils measured at saturation (Method 8E1, Soil Survey Laboratories) is similar to that measured at moisture equivalent. Resistivity at saturation for coarse-textured soils is generally lower than that obtained at moisutre equivalent and may cause the soil to be placed in a higher corrosion class.

2/ The relationship between resistivity of a saturated soil paste and electrical conductivity of the saturation extract is influenced

Very High Somewhat poorly to very poorly drained fine-textured soils. Mucks and peats with fluctuating water tables are included. Total acidity is greater than 16 meq. per 100 g. of soil or electrical resistivity at moisture equivalent is below 1,000 ohm-cm. at 60° F. or electrical conductivity of thr: saturation extract is greater than 1.0 mmhos per cm. at 25° c. (Very severely corrosive).

As soil reaction (pH) correlates poorly with corrosion potential, it is not included in the above criteria. Yet, there are some significant limits. A pH of 4 or less, almost without exception, indicates a high or very high soil corrosion potential. The most favored pH for sulfate reducing bacteria is 7; progressive departures in either direction indicates less and less favorable pH conditions. In wet or moist soils with anerobic conditions, especially clays that contain some organic matter and sulfate, a pH of about 7 is corroborating evidence for a rating of high or very high--ratings which such soils also would receive on the basis of drainage and texture.

Single soil property or soil quality determinations tempered by the knowledge of other soil properties and qualities that affect corrosion are useful in placing soils in relative corrosivity classes. A study of soil properties in relation to local experiences with soil corrosivity helps the soil scientist and engineer in making soil interpretations for soil corrosivity. Special attention should be given to those soil properties that affect the access of oxygen and moisture to the metal, the electrolyte, the chemical reaction in the electrolyte, and the flow of current through the electrolyte. Alertness needs to be maintained for the presence of sulfides, or the presence of mineral, such as pyrite, that can weather readily to yeild products highly corrosive to metals. If predictions are to be made of the soil corrosivity on steel pipe, it will be necessary to determine the corrosivity of each major soil horizon to a depth where the conduits are to be placed.

The probability of corrosion is greater for extensive installations that intersect soil boundaries or soil horizons than for installations that remain in one kind of soil or soil horizon. This probability should be mentioned in the text.

The use of soil corrosivity interpretations without considering the size of the metallic structure or the differential effects involved through use of different metals may lead to the wrong conclusions.

Related Problems Construction of buildings, paving, fill and compaction, surface additions, etc., that alter the soil permeability can increase probability of corrosion by providing a differential oxidation cell that accelerates corrosion in the less permeable portion of the soil or the portion receiving less oxygen.

Mechanical agitation or excavation that results in aeration and in nonuniform mixing of soil horizons may also accelerate the probability of corrosion.

Concrete   Concrete materials placed in soil deteriorates to varying degrees. Special cements and methods of manufacturing may be used to reduce the rate of deterioration in soils of high corrosivity. The rate of deterioration is related to (1) the amount:: of sulfates, and (2) soil texture and soil acidity. Three corrosivity classes will be used by the Service in making soil interpretations. These classes are:

Low   (1) Coarse and moderately coarse-textured soils and organic soils with pH > 6.5 or medium- and fine-textured soils with pH 6.0. (2) Soils with < 1,000 parts per million of water-soluble sulfates (as SO_4).

Moderate   (1) Coarse and moderately coarse-textured soils and organic soils with pH 5.5 to 6.5 and medium- and fine-textured soils with pH 5.0 to 6.0. (2) Soils with 1,000 to

Severe Considerable loss of surface soil materials can be expected. Rill erosion, numerous small gullies or evidence that considerable loss from sheet erosion may occur. Sheet erosion is indicated by frequent occurrence of soil pedestals and considerable accumulation of soil materials along the upslope edge of rocks and debris. This is accompanied by a probable fertility loss.

Very severe Large loss of surface soil material can be expected in the form of many large gullies and/or numerous small gullies or large loss from sheet erosion. Sheet erosion loss is exhibited by numerous examples of soil pedestals and extensive accumulation of soil materials along the upslope edge of rocks and debris. This is accompanied by a fertility loss.

2. Natural Stability This rating is based on the relative stability of the mapping units as they occur in the natural state. This includes any movement or loss other than surface erosion. by slumps. slides and all kinds of deepseated failures. This rating applies throughout Region 6.

I. Very stable - No evidence of failure.

II. Stable - Occasional failures are observed.

III. Moderately stable - Several failures are observed.

IV. Unstable - Many failures are observed.

V. Very Unstable - Entire area shows evidence of recent and past failures.

3. Nature of Mass Movement This is an estimation of the kind and/or size of mass movement observed.

Expected Mass Movement as a Result of Man's Activities This rating indicates the expected mass movement resulting from man's activities as compared to stability under natural conditions. Ratings are based on soil and bedrock characteristics, slopes, revegetation potential, and effects of timber removal, road construction and fire.

Unchanged - The expected mass movement is relatively unchanged from that of the natural state.

Increased - The expected mass movement is greater than that of the natural state.

Greatly Increased The expected mass movement is much greater than that of the natural state.

4. Subsoil Erosion Potential This interpretation indicates the potential for subsoil erosion by water for each unit. It includes erosion which takes place after the surface soil has been removed (about l-foot depth) such as in skid trails and

firebreaks. Factors considered in making ratings art? texture and structure of subsoil materials, slope, permeability, compaction, climate, and landform.

LOW - Factors are such that little or no erosion may occur. Very little evidence of erosion.

Moderate - Considerable erosion occurring such as rills and small gullies. Factors indicate considerable erosion is likely to occur.

High - Factors indicate severe erosion may occur.

Recommendations for Controlling Subsoil Erosion In this column recommendations are given, when applicable, for controlling subsoil erosion.

5. Water Yield Class This interpretation is an indication of the rate and amount of water yield expected from each soil. St is based on factors such as soil characteristics, infiltration rates, permeability, slope, climate, vegetation, and drainage patterns.

Class I - These soils have a high water detention storage capacity and a low rate of runoff. Little water is yielded to peak flows until detention storage capacity is exceeded or unless the soils are initially saturated or frozen. They are important in sustaining high base flow due to a relatively large volume of water held in detention storage.

Class II - These soils have a moderate water detention storage capacity and a moderate rate of runoff. Water contributes to both peak flows and base flow.

Class III - These soils have a low water detention storage capacity and a high rate of runoff. The storage capacity is low and easily exceeded with most of the water contributing to peak flow. Little water is yielded to sustain base flow.

6. Bedrock Hydrologic Characteristics This interpretation indicates the relative capacity of bedrock to store and transmit water. The rating is based on bedrock kind, texture, type and extent of fracturing, frequency of jointing, bedding characteristics, and degree of weathering.

Class I This indicates that the bedrock has a relatively high capacity to store water. The water transmission rate is low unless the storage capacity is exceeded. Rocks in this class include sandstones because of their texture, fracture and bedding characteristics; and basalts where water occurs in large tubes and other cavities or in the interflow zone between successive lava flows.

Class II This indicates that the bedrock has a moderate capacity to store water. The rate of water transmission is moderate. Rocks in this class are generally hard to moderately hard, moderately fine-textured, and moderately to highly fractured siltstone, mudstone, and pyroclastics.

Class III - This indicates that the bedrock has a relatively low capacity to store water. The rate of water transmission is rapid. Rocks generally in this class are fractured coarse crystalline (i.e., granite, gabbro and gneiss) and other hard-fractured rocks such as conglomerate.

Class IV - This indicates that the bedrock has both low storage capacity and low rate of water transmission. Rocks in this class are generally highly weathered, fine textured, and lack open fracture channels.

7. Hydrologic Group This interpretation is a grouping of soils into four classes, indicating the general infiltration and water movement ability of the soil and bedrock materials. This method of ratings has been developed by the Soil Conservation Service. The four groups are the standard SCS groupings and definitions.

Group A Soils having high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively drained sands and/or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

Group B Soils have moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water or, (2) soils with moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Group D Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with high swelling potential, (2) soils with a high permanent water table, (3) soils with claypan or clay layer at or near the surface, and (4) shallow soils over nearly impervious materials, These soils have a very slow rate of water transmission.

8. Expected Sediment Size This interpretation indicates the expected sediment size reaching the streams resulting from erosion of each unit. This interpretation is a statement of the two dominate separates expected (gravel, sand, silt or clay) from each soil unit. The ratings are presented in two columns. The first column indicates the separates expected from the surface soils, and the second indicates the separates expected from the subsoils.

9. <u>Sedimentation Yield Potential</u> This interpretation indicates the potential for water sedimentation and pollution from silt and clay particles carried in suspension following timber harvest, road construction, or other activities. Factors considered in making ratings are soil texture and structure, drainage patterns, landform and climate.

LOW Sedimentation levels of silt and clay particles are not expected to be significant following management activities. Soils are generally moderately coarse textured.

<u>Moderate</u> Sedimentation levels of silt and clay particles may be significantly increased following management activities with moderate loss of water quality and damage to fisheries. Soils are generally medium textured.

Nigh Sedimentation levels of silt and clay particles are expected to be high following managament activities. Streams become turbid and there is considerable loss of water quality and damage to fisheries. Soils arc generally fine to moderately fine textured.

10. <u>Water Resource Management Requirements</u> This interpretation indicates the relative level of management necessary to maintain high water standards in relation to quality, quantity and temperature. This interpretation also pertains to fishery values as affected by these water standards, and also to stream damage resulting from sidecast waste and/or slides caused by management activities.

<u>Low</u> This rating indicates that the management requirement necessary to maintain high water and fishery values are basic. The standard Forest Service protective measures are usually adequate.

<u>Moderate</u> This rating indicates that more intensive management practices are needed than arc commonly in use in order to maintain high water and fishery values. Measures required may include some or all of the following: intensive water bars on roads and trails, wet weather suspension on cat operation, restricted operation with cat blade, wet weather suspension on road construction, end-hauling of surplus waste, and skyline or swing logging systems.

<u>High</u> This rating indicates that very intensive protective measures are required to maintain high water and fishery values. These include such measures as the following: skyline or other swing system logging, minimum road density, minimal frequency of spur roads, strict requirements of surplus waste end-hauling, suspended road construction during wet weather, intensive water-barring and revegetation programs, and a critical analysis of cutting levels. This rating also includes soils of such a critical nature that timber removal should only be done by techniques that do not require road access.

11. Suitability of Soil as a Possible Clay Source This rating indicates the suitability of each soil unit as a possible source for clay. It does not indicate the kind or quality of clay or refer to any specific use of the clay.

Suited This rating indicates that the soil unit is a possible source of clay. Soils with this rating have the following: Texture ranges from clay loam to clay, Gravel content is less than 30 percent.

Unsuited Soils with this rating generally are not possible sources for clay.

12. Suitability of Bedrock for Road Rock This interpretation indicates the general suitability of rock when used as road rock for base course or wearing surface. These ratings are based on rock hardness, density, and susceptibility to weathering and breakdown. Soils are not rated when depth to bedrock is greater than 12 feet.

Unsuited Rock is soft and breaks down rapidly under logging traffic.

Poor Rock is only moderately hard and breaks down easily under logging traffic, usually in one or two years' time.

Fair Rock is hard and dense but tends to break down under logging traffic after about two to four years' use.

Good Rock is hard, dense and resists breakdown under logging traffic.

Limitations of Bedrock for Road Rock This column indicates the major limitation of the bedrock when used for road rock.

13. Estimate of Road Rock Thickness This interpretation refers to estimated amount of road rock base course and wearing surface) generally needed on heavy-vehicle, all-weather-use roads constructed on each soil unit. Factors involved in making this interpretation include texture and plasticity of soil, depth of bedrock, drainage, and kind of subgrade the road generally will have -- common material or bedrock. Ratings are based on uncompacted fills.

Very thin Generally less than 6 inches.

Thin Approximately 6 to 12 inches.

Thick Approximately 12 to 24 inches.

Very thick Generally over 24 inches.

Considerations for Road Location and Construction This column indicates the major considerations for road location and construction through each soil unit. The rating evaluates the impact of road construction on other resources and/or road construction problems likely to be encountered.

Method of Excavation This interpretation refers to excavation methods most commonly required for each soil unit. This includes soil, bedrock and cemented and/or compacted layers in the soil. Methods are blading, ripping, and/or blasting.

14. Susceptibility to Cutbank Sloughing and Raveling This rating evaluates each unit for its susceptibility to sloughing or raveling after excavation. Ratings are based on cutbanks at least 10 feet high. Factors include soil and bedrock characteristics, backslope ratio, frost action, climate and potential for revegetation.

Low Sloughing and/or raveling is a minor problems requiring occasional road maintenance,

Moderate Sloughing and/or raveling causes some damage. Annual road maintenance is usually adequate.

High Sloughing and raveling occur at a rate that often plugs culverts and fills inside ditches. Frequent road maintenance with heavy equipment such as front-end loader, is required.

15. Estimated Cutslope Ratio This interpretation estimates the cutslope ratio which generally will result in the most stable cutbank condition. Ratings made are for cutbanks at least 10 feet high and pertain to both soil and bedrock material.

Steep Cutbank ratio from vertical to $\frac{1}{4}$:1.

Moderate Cutbank ratio from about $\frac{1}{4}$:1 to 1$\frac{1}{2}$:1.

IV. Unstable Probability of 9 to 15 failures per mile of road cutbank.

V. Very unstable Probability of more than 15 failures per mile of road cutbanks.

17. Considerations for Cutbank Stability Problems This rating gives recommendations, when applicable, to increase stability of cutbanks or reduce damage from raveling and sloughing.

Failure and Erosion on Rond Waste and Fills This interpretation rates the soil units as to the susceptibility of failure and erosion occuring on fill and sidecsst waste material and related damage to resources. Failures are defined as a loss or partial loss of road fill or sidecast material on the fill slope. Erosion is a loss of surface soil material from fill or sidecast. Considered are initial and subsequent failures caused by construction, erosion and additional sidecast during maintenance. Failures result in damage to various resources. Stream sedimentation levels are increased, resulting in an adverse effect on both water quality and fisheries. Timber growth potential is affected as fill-slope areas no longer contribute to production. Occasionally the failures do damage to the road itself. The ratings are based on current road construction practices and procedures and on type of soil materials, natural drainage of the site, landform, slope of the fill, and field observation.

Low Failure and erosion on road waste and fills is sufficiently low to result in only minor damage to resource values.

Moderate Failures and erosion on road waste and fills occur with sufficient frequency to cause moderate damage to resource values.

High Failures and erosion on road waste and fills occur at a rate and magnitude sufficient to cause major damage to resource values.

Suitability of Cutbanks to Seeding This interpretation indicates the probable success of cutbank seeding. Factors considered in making ratings are soil characteristics, elevation, slope, climate, snowpack, and frost hazard. Ratings are based on current methods and practices of seeding, grass species, fertilizer application and time of seeding.

Poor Probability of success is low. Seeding generally is not successful and requires 3 or more reseedings and special treatments.

Fair Success is likely on about 50 percent of area treated. Requires one or two followup treatments. Seeding is usually spotty, some areas become easily estabilished, while others fail completely.

Good Probability of high success. Seeding usually becomes well established within two years. Little followup seeding necessary.

Limitation to Cutbank Seeding This indicates the major limitations to success of cutbank seeding.

Recommendations for CutbankS51376.5599976 693.333 648 cm BI /W 115 /H 20 /BPCS /G / CS /G / Đ

0 1 299.28 6648.72 Tm ecessary.

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

Honolulu, Hawaii
January 23-28, 1972
Committee 7

Report of Committee 7 - Soil Interpretations at the Higher Categories of the Soil Classification System.

This Committee received the following charges from the Conference Steering Committee.

Charge 1 - Evaluate the use of small scale maps, legends, and related interpretive tables used in the higher categories of the classification system; and prepare ways to set forth interpretations for taxa in the higher categories.

Charge 2 - Prepare a chart showing the degree of reliability that different interpretations can be made at different categorical levels.

Comments from committee members indicate there is still considerable disagreement as to the degree of usefulness of small scale maps and related interpretations at the higher categories of the soil classification system.

The discussion of the charges reflects the summation of the opinions and comments of the committee members response to the charges.

Many of these comments are not new. They may have been made in various forms by past committees on this subject, or by committees or workshops on related subjects.

Charge 1 - It is the general consensus of the committee that small scale maps are very useful. Furthermore, the demand for these kinds of maps is expected to increase greatly in the future.

It appears that these small scale maps may be most beneficial in comprehensive planning by planning groups, both private and government, legislators, and other governmental agencies at all levels.

Small scale maps may be constructed from three sources. For areas that have detailed surveys, they can be generalized at any categorical level. Where detailed surveys are not available they may be prepared from reconnaissance mapping, or they may be synthesized from available information without new mapping.

The family has perhaps been the most widely used category of the classification system at the present time to collect data by reconnaissance soil surveys. The interpretive potentials available in relation to the cost of the survey is probably responsible for the present soil mapping at this level.

Where considerable detailed mapping, classification, and correlation has been completed, map unit components can be series and phases, if desired. If soil series names are familiar to much of the public in the area of concern, this is perhaps the simplest and most convenient way to identify and discuss the soils. For areas that lack previous mapping, classification, and correlation, the soils can be named using the nomenclature of the classification system. This has advantages and disadvantages. The major advantage is that many of the properties of the soil are contained in the name. Probably the major disadvantage is that a certain familiarity with the classification system is required in order to understand and interpret these properties.

Regardless of the categorical level used, phases appear to be essential for improving interpretive potentials. For instance, on a legend designed at the family level, phases will allow interpretations to approach those available at the series or phase of a series level. The family has the additional utility of combining under one name soils that could be several series. This concept is applicable at any of the higher categorical levels. Phases of taxonomic units using the nomenclature of the classification system can develop overly long and unwieldly names. This is especially a hazard at the family level. Legends should be kept simple, but must be adequate for the user to determine the appropriate interpretation to find the desired information pertaining to the area of concern.

Tables may possibly be the most feasible way to present the information on soil characteristics and qualities, and their interpretations for uses. The major user is not likely to be the general public, but people who are familiar with and use tables in much of their work. Interpretive maps can then easily be prepared from the tables if desired.

The narrative can possibly be best used to describe how to recognize the soils and should include other information that is difficult to put into tables.

Notes on discussion of the report by the Conference. (Comments are paraphrased)

Knox: Recommendation 5. It is not apparent why only one categorical level is used throughout the legend.

Gallup: By using several categorical levels in a legend we may be implying more precision in one mapping unit than another. Also for ease of recognition we do not mix categorical levels.

Douglass: You can obtain a simpler map by using one categorical level.

Mitchel: The national committee has previously rejected this idea.

Douglass: Recommendation 6. Don't you want to make interpretations for the mapping unit?

Spencer: For single factor maps you will want to make interpretations for the mapping unit, but you will need to make interpretations for each component member of the mapping unit before an interpretation can be made for the mapping unit.

Johnson: You are confusing several steps. Primarily you must know the landscape. You must combine interpretations depending on the projected uses of the survey. For most uses this can be done. This is step-wise because ultimately you must consider several mapping units. Don't forget you go far beyond soils data when planning an area.

Mitchel: Maybe it would be best to include mapping units in this recommendation.

Spencer: There are differences in scale used for mapping. We must remember what the projected uses of the survey are.

?______: Recommendation 7. Do you really mean this?

Spencer: It may be unfair to the user to show ranges. If you have investigated the soil many of these single values can be determined and the single value may have a greater utility.

Bartelli: You may be implying a more precise determination to the user with a range than with a single value.

Mitchel: Maybe it would be best to give a single entry for estimated physical and chemical properties in the engineering tables.

Jack Williams: How do you phase at the family level?

Spencer: You can use any of the presently used phase conventions that are used when mapping at phase of the series level as in a detailed survey.

Bartelli: Scale of mapping is a very important aspect and must be considered as primary. You must know what information is desired from the survey. Most manuscript general soil maps are not adequate for making interpretations.

Hole: You must make a distinct separation between general soil maps that are constructed from detailed soil surveys and reconnaissance soil surveys. The latter are not general soil maps. They are designed soil surveys.

Giese: Dr. Kellogg has stated in the past that general soil maps are small scale maps. Reconnaissance soil surveys are not the same.

Corliss: Objectives of a soil survey must be clearly stated and understood before we can map soils.

Bartelli: Small scale maps should be used as a planning tool.

The report was accepted by the conference.

Charge 2 - The committee did not prepare a chart showing the degree of reliability for different interpretations at the different categorical levels. Any interpretation made should be reliable in relation to purpose and scale of map regardless of the categorical level. This does not mean that use of data at different categorical levels and map scales is intended to serve identical objectives. Obviously this cannot be. The right tool must be used for the right job. This means choosing the appropriate categorical level that will provide for the objectives desired.

The reliability of interpretations is only as good as the state of our knowledge at the time they are made. For this reason, it would seem appropriate to include the criteria used in making the interpretations as a part of the report.

In summary, the committee suggests the following as guidelines to designing legends and presenting interpretations at the higher categories.

1. The categorical level must accommodate the scale of map and provide for interpretations for the desired objectives.

2. Map units should provide for interpretations of taxonomic units.

3. Phases are essential for reliable interpretations.

4. Phase names should be as short and easy to use as possible. One soil characteristic is the most desirable. Three characteristics should be the maximum. A lower categorical level should be used if phase names must exceed three soil characteristics in order to achieve the objectives.

5. One categorical level should be maintained throughout the legend if possible.

6. Interpretations should be by taxonomic units rather than map units.

7. Interpretations should consist mostly of single values rather than ranges.

8. Suitability and limitation ratings should include the characteristic that places the soil into that rating.

9. The interpretive criteria should be made a part of the report.

The committee recommends that it be continued with the following as possible areas to explore.

1. Investigate alternatives for naming map units and taxonomic units at the higher levels.

2. Suggest methods and procedures for correlating soils at the higher levels for reconnaissance surveys.

3. Explore the interpretive potentials available at the different categorical levels.

The following references are some recent examples of different methods that have been used for presenting small scale maps, legends and interpretations.

1. Water and Related Land Resources for Central Lahontan Basin, Nevada, Appendix I - SOILS. 1971. Soil Conservation Service.

2. Soil Associations and Land Classification for Irrigation, Dona Ana County. New Mexico State University. Agricultural Experiment Station, Research Report 183. 1971.

3. Soil Associations and Land Classification for Irrigation, Harding County. New Mexico State University. Agricultural Experiment Station, Research Report 165. 1970.

4. Water for Nevada - A Reconnaissance Soil Survey of Railroad Valley. Division of Water Resources. 1971.

Committee Members:

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SOIL SURVEY PROCLDURES

Committee 8

The charges given this committee are:

Charge 1.

Many soil scientists have differences of opinion as to how soil descriptions from published soil surveys may bc used in preparing a descriptive legend. Consider and propose procedures for using soil descriptions from a published soil survey and preparing an initial draft of the descriptive legend for an adjoining county or area of similar soils of which the survey is being started.

Charge 2.

Electronic equipment and automatic data processing procedures should be evaluated for possible use to increase efficiency of soil survey procedures. At this stage, greater emphasis is needed on studies to determine the feasibility of preparing series descriptions, soil interpretations, and other parts of soil survey manuscripts applying to any of the series in a discrete phase of a family. This should consider and prepare recommendations for use of such interpretations on the basis of families in lieu of single interpretive sheets developed for each series for use in preparing soil survey reports.

Charge 3.

Consider nomenclature for naming, techniques and procedures for correlation and development of soil interpretations for small scale maps (reconnaissance). Some attention should be given to the field techniques of mapping, kinds of areas suitable for reconnaissance type of mapping, and design of mapping units where this type of mapping is adequate.

Repot-t:

Charge 1.

There is full agreement on the need and desirability of using soil descriptions from published surveys in preparing descriptive legend material for new survey areas. Generally the methods and techniques are very similar. Major steps include:

1. Review and r-valuate previous work, field investigate if necessary for adequate evaluation.

2. Review and evaluate present classification and correlation of series involved to determine current status.

3. Design mapping units for objectives of present survey area with maximum utilization of previous material. It must be kept in mind that different areas, even in the same survey, may have somewhat different objectives of the survey.

4. [luring progress of the survey, revise tht; descriptions as necessary to accurately reflect conditions in the survey area.

Specific techniques may vary but general principles of application will hold. The committee members fully endorse the position on this subject taken at the 1971 National Meeting in Charleston, South Carolina. This position is stated on page 212 of the proceedings of that conference.

Charge 2.

Electronic and automatic data processing for soil survey program procedures is gaining favor. Some units are

Suggestions included federal agencies, state colleges and experiment stations. It seems reasonable that all of these should be involved. It is imperative that all who are involved in the soil survey program assist by acquiring and furnishing to the ADP centers the best information possible and that there be coordination.

Henry Homan, Head, Cartographic Unit, Portland, presented additional information on AOP at the end of this report.

Apparently the idea of preparing sail interpretations on the basis of families or phases of families rather than soil series is quite new for the response to this proposition was quit? light. The Soil Conservation Service in the State of Oregon has experimented some, as has Nevada, in developing soil interpretations for their reconnaissance soil surveys. Some difficulties were encountered. The number of established soil series is increasing as is the application of reconnaissance soil surveys. Automatic data processing and using families or phases of families as the basis of soil interpretations offer a potential for considerable saving in time and effort. For example, there are many instances where all series within one large family have the same or nearly the same interpretations -- why duplicate time and effort in processing and coordinating interpretations for each of these series. Recognizing that there are some problems with family criteria, it seems worthwhile to continue to explore and test possibilities.

It is recommended that efforts continue to adapt all phases of the soil survey program to automatic data processing and that progress in this activity receive more widespread publicity so that it can receive greater support by all who are engaged in the soil survey program.

The committee recommends continued and more widespread efforts to use families or phase of families for the basis of soil interpretations.

Charge 3.

Although there was not complete understanding on what constitutes a reconnaissance type soil survey, there was sufficient agreement to proceed on the definition in the draft material for the Soil Survey Manual revision. There is one additional working principle that should be adhered to for considering this committee report. It involves the concept of soil surveys. There are other kinds of surveys such as geologic surveys, vegetative surveys, physiographic surveys and others. For the purpose intended, these have validity and are very useful. They are not soil surveys. They can contribute much useful information to the making and the use of soil surveys but they are distinct. Soil surveys attempt to delineate areas or mapping units primarily on the basis of sail characteristics; other kinds of information useful to soil use and management may be recognized and used to supplement soil characteristics.

field Investigation Techniques

It was generally agreed that usual soil survey procedures of detailed survey are needed. These include:

1. Gathering and reviewing all available data such as soil surveys of similar or close-by areas, geologic, geomorphic. climatic and vegetative information for the area.
2. Preliminary study of aerial photography.
3. Preliminary field study of the area relating observable features with photo imagery.
4. Preliminary delineation of similar areas, based on soils, landscapes, geology, and vegetation.
5. Field surveying and describing as many delineations as practical using accepted soil survey procedures.
6. Detail map sample areas and/or transect to determine composition of mapping units.
7. Sample as needed for characterization, verification of classification, interpretations, and for correlation.

Since there are no major deviations proposed from already accepted methods and procedures, the committee makes no recommendations.

Design of Mapping Units (function of scale and landscapes)

There was general agreement that the design of mapping units should follow accepted soil survey Practices. Mapping units should be designed to furnish the information for the objectives of the survey and intended land use and management. This will vary considerably, depending on present and potential land use. Mapping units should be designed to furnish the users with adequate soil information and yet allow for rapid completion of the survey.

Present procedures recognize the soil association as the primary mapping unit for reconnaissance soil surveys. No comment was received concerning the recognition of complexes or undifferentiated groups as defined in Soils Memorandum-66. Apparently there is full agreement on use of soil associations as the basis for designing mapping units for reconnaissance soil surveys. No recommendation is made by the committee because there were no proposals received for any changes to presently accepted methods and procedures.

Naming of Mapping Units

There is general but not complete agreement on how to name units. The majority favored soil taxonomic names for sail areas, supplemented by miscellaneous land type names for non-soil areas. Soil taxonomic names ranged from soil series or phases of soil series where possible to higher categories of Soil Taxonomy, but at the lowest level practical.

Examples: Balen silt loam
Balen
Balen family
Typic Calciorthid, fine-loamy, mixed, mesic, steeply sloping
Typic Calciorthid, fine-loamy, mixed, mesic
Typic Calciorthid
Calciorthid

It is recommended that mapping units tor reconnaissance soil surveys be named In terms of soil series and/or Soil Taxonomy except non-soil area which would be identified by approved miscellaneous land type terms.

It is also recommended that a procedure be adapted for naming reconnaissance type mapping units that would generally make them distinct from more detail mapping units.

Describing the units and recognition of soil and/or other components of the unit not included in the mapping unit name

There was majority but not complete agreement in the committee on this subject. There was good agreement on describing soil areas as completely as possible in soil tens supplemented as needed for clarity and completeness with other related information. Most members favored use of profile descriptions as part of descriptive legend. There was less agreement on use of profile description in reports. Major inclusions should be identified by a name if possible or briefly described and percent composition given.

It is recommended that no changes be made from presently accepted soil survey methods and procedures for describing soil units and mapping units of reconnaissance soil surveys.

Correlation of soil units recognized at categorical levels higher than soil series

There is a variation of opinion in the committee on this subject. depending upon how the mapping units are named.

Within the concept of soil survey as conducted in the National Cooperative Soil Survey. some degree of correlation is essential.

Soil correlation is the scientific method by which the set (or combination) of all the significant characteristics of each soil is specifically compared with the sets of characteristics of the already defined and named kinds of soils in the taxonomic system and thereby thr soil gets its name and place in the system.

In actual operation soil correlation includes:

1. Standards for the descriptions of the characteristics of the soils and their associated environments.

2. Definitions of kinds of soil as specific combinations of these characteristics by synthesis of the descriptions of like soils.

3. Development, maintenance, and continual revision of the system of soil classification.

The development of Soil Taxonomy, with its orderly categories above the soil series, has furnished the basis for useful and practical reconnaissance type soil surveys in areas where little soil knowledge is available. To test and improve Soil Taxonomy and subsequently improve all soil surveys, it appears that soil correlation offers the best and most practical route. Recognizing that some new techniques may be desirable and correlation may consume some time, it would seem that over a period of time the efforts would be well justified.

It is recommended that soil correlation continue on all recognized soil surveys and that efforts be made in the correlation process to expedite reconnaissance soil surveys to meet their objective of furnishing soil information on extensive use areas in the shortest time possible.

DISCUSSION AND COMMENTS:

Charge 1.

No comments from floor.

Charge 2.

No comments from floor.

Charge 3.

A. Design of Mapping Units

1. Question: What is meant by design of mapping unit?

Victor G. link referred t" Soils Memorandum-66 defining mapping units with various taxonomic components.

Discussion: Let the potential users comment on what they need early in the survey so the mapping units can be designed accordingly.

2. lhere was considerable floor discussion on the use of undifferentiated groups and complexes in addition to associations. Soils Memorandum-66 was referred to several times to clarify definitions.

Conference participants were not in full agreement with definitions in Soils Memorandum-66.

B. Naming of Mapping Units

The following comments reflected the apparent majority opinion of participants:

1. If taxonomic units are defined and described only down to the soil family, they should be named at this level and not be designated by a soil series name only.

2. Generally. mapping units should be set up at the family level and need not be carried on down to soil series.

3. If there is no family presently recognized, a series must be set up to establish recognition of the family.

4. Recognition of taxonomicreco3ecognitcomn0.01 1 0 0 w 0 0unit1 0 1 193.44 46 (96o3ecognitq 32.3999918200

SOIL FAMILY CRITERIA

Committee 9

The committee received the following charges:

I. Review and evaluate the use of family groupings for interpretations; outline problems encountered, and prepare proposals as needed for improvement.

II. Prepare list showing where and how family groupings have been used in interpretations.

III. Do we have families that are not needed? How should single series families be handled?

IV. Is the present method for selecting a common family name satisfactory? If not prepare a proposal for another alternate method.

Committee actions and recommendations.

I. Use of families in interpretations.

A survey of committee members and associates showed interpretations at the family level are relatively few. Some activity is in progress but there was inadequate experience to provide a good inventory. The work in California has indicated some problems.

In California the placements into hydrologic groups using 16 families in 8 subgroups showed correct placement for 25 percent of the families, 25 percent were only 50 percent correct and the remainder ranged from 50 to 80 percent accuracy. Average accuracy was about 75 percent.

Dick Kover, in California evaluated shrink-swell ratios and found variabilities of similar magnitudes.

Problems and proposals

1. Need to make certain that series are correctly defined, evaluated and rated.

2. Need to appraise critically the mineralogical criteria and the significance of families separated solely on the basis of mineralogy.

3. Most surveys have been made using series oriented legends and there appears to have been little inclination to make interpretations at the family level when series data are available. There is a need to purposely construct legends that will result in mapping units as phases of families.

4. This will also require clarification of correlation procedures for mapping units defined at family or higher categories in the system.

II. When and how were family groups used for interpretations.

Oregon - used family criteria in grouping soils for engineering purposes.

California - tested family groups as a level to evaluate hydrologic groups and shrink-swell ratios.

III. Status of families

A. The family picture in the Western States.

1. A total of 1592 families used in the West contain only one series each.

2. Some great groups contain a disproportionate share of the single-series families:

a. There are 113 single-series families in Haploxerolls.

b. Six great groups have 50 or more single-series families.

(1) Calciorthids - 56

(2) Camborthids - 53

(3) Haplustolls - 51

(4) Argixerolls - 56

(5) Torriorthents - 86 (6) Haploxerolls - 113

c. Thirteen great groups have 30 or more single-series families.

d. Forty-nine great groups have 10 or more single-series families.

e. Eighty-nine great groups have 1 through 9 single-series families

Comments:

Most of our series in the Western States fall in these great groups. Currently family criteria do not seem to resolve this problem.

Most committee members felt that a single series family was not critical, but no suggestions were available for reduction of the number. The above picture warrants examination of differentiating criteria to determine if in these great groups the differentiation should be at the series rather than the family category. The committee did not have the picture in time to study this aspect.

B. Naming of families

1. Current procedure

a. Only established series are selected. If all of the series in a given family are tentative, no series name is selected to name the family.

b. Preference is given to the most well-known or prominent series. This has been judged mainly on the basis of the number of final correlations in which the series has been used or the number of publications in which it has appeared.

c. The selected series should be of extensive acreage. If two series are established and are in an equal number of final correlations, the one with larger acreage is selected.

d. If several established series are in the same family there has been a tendency to pick the oldest series over one recently established.

e. In the case of two established series that are equally qualified in other regards, preference is given to names that are easy to spell and pronounce.

f. If only one series is in the family, no common family name is designated.

g. Series are not selected if classification is provisional.

C. Problems

1. Some established series are very old, poorly defined, and not well known. Some of them were established on the basis of small acreage, before we started emphasizing minimum acreage requirement for a series to be established. Yet, in a given family, this may be the only established series. Some of the tentative series of the family may be better known, better defined, and of much larger acreage.

2. Closely related is the problem of selecting between established series on the basis of age. The older series may not, in some cases, be the better choice if we consider prominence, acreage, adequacy of description, etc.

3. "Well-known or prominent" is a little difficult to define in terms that everyone will accept. A "well-known" series in the one state or region may be unknown in another state or region. This has led to having two series designed as common names for the same family in a few cases, where the family extends across two or more regions.

Comments:

A majority of the committee thought the name should be more descriptive. Terminology as "fine loamy, mixed, mesic" provides a more meaningful name to users not trained specifically in soil science.

The committee recommends that descriptive terminology be used in family names as a first preference, such as Typic Calciorthids, fine loam, mixed, mesic, steeply sloping.

Committee 8 has made recommendations on the naming of mapping unite at various levels of of the system. Their second proposal most closely approximates the desires of the majority of the members of Committee 9.

General Comments and Recommendations

1. There is a distinct need to further evaluate family criteria to determine whet modifications may be desirable LO cope with the large number of single series families. These should be considered in relation to great group and subgroup criteria.

2. Interpretations at the level of the family group needs testing on a fairly broad scale by appraising possibilities on completed surveys and by constructing legends with mapping units as phases of families. Each state should attempt to study at least one survey area in each of these situations.

3. The committee should continue to implement these studies

Committee Members

*R. F. Bauer	*R. C. Huff	*R. F. Mitchel
"3. E. Brown	*E. K. Knox	P. C. Singleton

*T. B. Hutchings
Chairman

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY
HONOLULU, HAWAII
JANUARY 23-28, 1972

REPORT OF COMMITTEE 10
HISTOSOLS

This committee, a new one in the western region, was assigned six charges based on recommendations by the National Committee on Histosols. These are:

1. Collect soil temperature data on organic soils.

2. Develop a taxonomic key for soils of the region.

3. Develop meaningful consistence terminology for use in describing organic soils.

4. Develop standard moisture (water content) terminology for use in describing organic soils.

5.a) Review the criteria for rating soils for subsidence potential attached to the report of the National committee.

b) Revise or enlarge the table of subsidence potential classes to include classes for pergelic soils.

6. Evaluate test data and recommend if the rubbed fiber percentage for sapric materials should remain at 10 percent or be raised.

Charge 1. Soil Temperature Data

Information on temperatures of organic soils in the western states is apparently not readily available. A call for data from each state in the region produced only three replies. For only two soils, both in southeastern Alaska, was it possible to compute the mean temperature for one complete year. The mean annual temperature in these soils (Kina, a Typic Cryohemist, and Maybeso, a Terric Cryosaprist) was 4° to 4.5°C lower than the mean annual air temperature. It is not possible, of course, to draw any firm conclusions about the relationship between temperatures in organic soils and air temperatures from this meager information.

The temperature data obtained from Alaska, Hawaii, and California are presented in Tables 1, 2, and 3.

Charge 2. Taxonomic Key for Histosols in Western Region

Tabular keys for rapid identification of suborders, great groups, and subgroups of Histosols in the western region have been developed by Ellis G. Knox and are attached to this report. The tables could be expanded to include great groups and subgroups that do not occur in the western states, and it would be possible to add a table for family criteria. It is likely that keys of this kind can be prepared for every order in the classification system.

Charge 3. Consistence Terminology for Organic Soils

At present, the same structure and consistence terms are used in descriptions of both mineral and organic soils. For the coarser organic soils, many of these terms are inapplicable. Commonly, but not always, structure and consistence are related and can be described simultaneously by a single term. In many cases particle size, or length of fibers, is also implied by the term. Only in sapric materials are these properties consistently related to moisture content.

Some terms that have been used in the past in descriptions of organic soils are:

For fibric and hemic materials -- matted, felty, stringy, fluffy, spongy, compact, crumbly, laminated.

For sapric materials -- amorphous, colloidal, rubbery, elastic, cohesive, granular, friable, hard, sticky, plastic.

We suggest that, in describing the consistence and structure of fibric and hemic materials, the most suitable terms to retain are matted, compact, crumbly, and laminated. The word loose could be used for the low bulk density condition indicated by fluffy or spongy. For sapric materials terms may be carried over from the mineral soil consistence terminology, except that very firm and extremely firm are not likely to be needed for moist materials and loose, soft, and extremely hard are unlikely in

Table 1. **Soil Temperatures in Organic Soils, Alaska**

Series	Subgroup	Date	Temp (°C) at 50 cm
Hydaburg	Lithic Cryohemists	7/16/69	5
"	" "	10/10/69	4
Kaikli	Lithic Cryosaprists	7/15/68	7
"	" "	10/15/68	6
Karheen	Typic Cryosaprists	7/16/69	6
"	" "	10/10/69	5
Kina	Typic Cryohemists	4/15/68	5
"	" "	7/15/68	11
"	" "	10/15/68	7
"	" "	1/15/69	1
"	" "	9/13/71	10
Kogish	Cryic Sphagnofibrists	7/16/69	6
"	" "	10/10/69	6
"	" "	8/14/71	11
"	" "	9/13/71	11
Maybeso	Terric Cryosaprists	4/15/68	4
"	" "	7/15/68	10
"	" "	10/15/68	7
"	" "	1/15/69	1
Salamatof	Typic Sphagnofibrists	9/2/71	3
"	" "	9/2/71	5
Sunnyhay	Lithic Cryosaprists	7/16/69	9

All of these soils except the Salamatof series are in southeastern Alaska. The Salamatof soils are in south-central Alaska.

Table 2. Soil Temperatures in Tropofolists, Hawaii

Soil Series	Family	Brief Description	Field Observations August 17, 1971 Elevation (feet)	Depth Temperature Taken (inches)	Soil Temperature Readings
Lalaau	Dysic, isomesic	2 to 8 inches muck, underlain by fragmental Aa lava	6,900	8	13°C
			4,000	12	15’
Kiloa	Dysic, isothermic	3 to 12 inches muck. underlain by fragmental Aa lava	3.000	8	17’
Keaukaha	Dysic, isohyperthermic	3 to 10 inches muck, underlain by pahoehoe lava	1,000	12	21”
Malama	Dysic, isohyperthermic	2 to 8 inches muck. underlain by fragmental Aa lava	400	18	25’
Opihikao	Dysic, isohyperthermic	2 to 5 inches muck, over pahoehoe lava	400	12	25’

Table 3. Soil Temperatures in Organic Soils in the Sacramento-San Joaquin Delta, California.

Soil	Date	Time	Soil Temp 50" cm	Air Temp	Remarks
Kingile muck	10/1/70		23°C		Mineral soil
	2/19/71	3:oo p.m.	12’		
	8/12/71		21°	37°C	Tall corn
	8/12/71		23°	37°	Asparagus
	8/23/71	10:45 a.m.	19°	22°	Tall cot”
	11/19/71	12:30 p.m.	18°	20°	Dry
	11/19/71	12: 30 p.m.	12’	20’	Flooded
Kindge muck	9/21/70		21’		
	2/19/71	4:15 p.m.	10°		
	8/23/71	10:50 a.m.	23°	27°	Tall corn
Venice muck	9/22/70		19’		
	2/19/71	3:15 p.m.	9°		
	8/12/71		21’	37”	
	8/23/71	10:20 a.m.	21°	24°	
	11/19/71	1:30 p.m.	17’	20”	Dry
	11/19/71	1:30 p.m.	9°	20’	Flooded

Mean annual soil temperatures closely approximate water temperatures in adjacent channels. These are about 17°C. with lows of 7” to 10’ in winter and highs of about 24’C in summer.

dry materials. I” addition the terms elastic (for vet and moist soils), granular. and massive would be useful.

Precise definitions are needed far each term, and a “umber of other properties such as fiber shape and size. strength of fibers relative to the cohesion between fibers, and the spatial orientation of fibers need to be described systematically. We recommend that these standards be developed by a national committee composed of people who are experienced in working with organic soils.

Charge 4. Standard Moisture Terminology for Organic Soils.

A test at the Riverside laboratory indicates that, in general, properties of organic soil materials such as color or fiber content do not change with changes in moisture content. Two samples of dry O horizon material were wetted under tensions of 8 cm (water films surround fibers), 30 cm (films appear only when organic material is compressed slightly), and 60 cm (no films eve” under firm compression) with “o resulting effect on color or measured fiber percentage.

Field observations confirm these tests except in the case of sphagnum moss peat and, in some instances, partially decomposed (hemic) sedge peat. Characteristically, peat derived from sphagnum becomes 1 to 3 value steps lighter and may change 1 or 2 chroma steps in either direction when moisture is pressed from the peat. The intensity of change is greater in undecomposed than in partially or well decomposed peat. Some hemic materials gain one step in chrome when squeezed. So far as is know”. there is no corresponding change in any other property.

Because colors in some organic soils do vary with moisture content (in fact, this variation is a useful aid in the identification of sphagnum peat). it would be desirable to have standard field moisture conditions for at least this measurement. We suggest that colors be determined at the point at which free water films just disappear from fiber and other surfaces, and again after as much water as possible has bee” squeezed out of the sail with the fingers.

As noted above, moisture condition must be specified in determinations of consistence of sapric materials. It is likely that the terms vet and moist should be defined differently for organic than for mineral soils. We suggest the following:

Wet - moisture films visible on surfaces of organic material.

Moist - moisture films visible only when soil is compressed.

Dry - air dry.

Charge 5. Rating Organic Soils for Subsidence Potential.

The criteria for rating soils for subsidence potential that were developed in Louisiana were tested in the Sacramento-San Joaquin Delta end appear to be satisfactory in that area. The ratings, which are reproduced in Table 4, refer to total rather than annual subsidence.

Table 4. Subsidence Potential as a Result of Drainage

Class	Subsidence Potential (inches)	Soils
Low	0 to 3	(1) Mineral soils with organic surface accumulations 0 to 3 inches thick. (2) Mineral soils with semifluid layers (greater than 100 percent saturated with water).
Medium	3 to 16	Mineral soils with organic surface accumulations 3 to 16 inches thick.
High	16 to 51	Organic soils with organic accumulations 16 to 51 inches thick.
Very High	> 51	Organic soils with organic accumulations greater than 51 inches thick.

The committee recommends that these criteria be adopted for the western states, except for pergelic soils.

The amount of subsidence in pergelic soils--both mineral and organic--following clearing and/or drainage depends largely on the quantity of ice contained in the soils. In some cases the ice may be uniformly dispersed through the soil mass, but more commonly it exists in the form of clear ice lenses or masses. In soils of this kind, the proportion of ice varies widely even within short distances. As a result, soils which are warmed because of the removal of vegetation, an insulating surface mat, or water perched above the permafrost table during the summer settle irregularly and it is difficult to predict even an average subsidence rate. Subsidence is most rapid in the first few years after the soil is warmed. Although the rate slows thereafter, soil stability is seldom attained because of irregular swelling during periods of refreezing and continued recession of the permafrost table.

Charge 6. Fiber Percentage in Sapric Materials.

In the absence of test data, the committee was unable to respond to this charge.

J. E. Brown
R. C. Huff
E. G. Knox
W. D. Nettleton
S. Rieger, Chairman

APPENDIX - REPORT OF COMMITTEE ON HISTOSOLS

Criteria for Soil Classification:
Suborders, Great Croups, and Subgroups of Histosols

Ellis G. Knox
November 1971

This paper presents tabular keys and supporting criteria for the identification of suborders, great groups, and subgroups of Histosols. The two tables and twelve criteria present the specifications for classification in these categories according to the soil classification system of the National Cooperative Soil Survey (Soil Survey Staff, 1970). Great groups not represented in the United States and subgroups not represented in the 13 western states (Soil Families of the United States and their Included Series, September, 1970) are not included.

The system operates by division, starting at the highest category. It is necessary to identify the order, suborder, great group, subgroup, family. and series in that sequence, down to the category of interest.

The tables in this paper apply only to soils already identified as Histosols. Table 1 shows criteria for suborders and great groups. Table 2 shows criteria for subgroups. Table 2 can be used only for the identification of subgroups within a give", previously identified great group.

Except for Sulfihemists and Sulfohemists, soils in great groups and subgroups not included in the tables will be placed into the right suborder in Table 1.

The tables specify for each class the criteria that are required for that class (R and A). the criteria that are not permitted for that class (0), and the criteria that are not critical in the definition of the class (N). The symbol A indicates that two or more criteria are alternatives and that at least one of the alternatives is required, For example, Fibrists require criterion 1, and at least one of criteria 2 and 4. Criterion 3 is permitted but not required. A soil that satisfies criteria 1, 3, and 4 but not criterion 2 is a Fibrist. Satisfaction of criterion 1 eliminates Folist. Failing criterion 2 eliminates none of the suborders. Satisfaction of criterion 3 eliminates Saprist. Satisfaction of criterion 4 eliminates Hemist (also Folist and Saprist). Thus, the soil meets the requirements for Fibrist and for no other suborder.

This material for Histosols is based on a paper, Criteria for Soil Classification in the Higher Categories of the U.S. System, by Ellis G. Knox, May 1971.

CRITERIA

1. Wet. Saturation with water, or with artificial drainage, for 6 months or more during the year. (The

Hemic soil material is an organic soil material intermediate between fibric and sapric soil material.

Sapric soil material is an organic soil material (1) in which fibers constitute less than 1/3 of the organic volume or after rubbing constitute less than 1/10 of the organic volume, and (2) which yields a sodium

Suborders and
Great Groups

Fibrist
Folist
Hemist
Saprist

Borofibrist
Cryofibrist
Medifibrist
Sphagnofibrist

Borofolist
Cryofolist
Tropofolist

Borohemist
Cryohemist
Medihemist

Borosaprist
Cryosaprist
Medisaprist
Troposaprist

R = Required citerion
A = Alternative criterion. (One of the alternatives is required).
N = Neutral criterion, permitted but no required.
O = Prohibited criterion or one impossible by definition.

Table 2. Criteria for Subgroups of Histosols in the 13 Western States.

Subgroups	Criteria					
	7 Cryic	8 Pergelic	9 Fluventic	10 Limnic	11 Lithic	12 Terric
Terric Borofibrist			N	N	O	R
Typic Cryofibrist		O	O	O	O	O
Fluventic Cryofibrist		O	R	O	O	O
Pergelic Cryofibrist		R	N	N	O	N
Typic Sphagnofibrist	O	O	O	O	O	O
Cryic Sphagnofibrist	R	O	O	O	O	O
Pergelic Sphagnofibrist	R	R	N	N	N	N
Typic Borofolist					O	
Lithic Cryofolist					R	
Typic Tropofolist					O	
Lithic Tropofolist					R	
Typic Borohemist			O	O	O	O
Terric Borohemist			N	N	O	R
Typic Cryohemist			O	O	O	O
Lithic Cryohemist			N	N	R	N
Typic Medihemist			O	O	O	O
Limnic Borosaprist			N	R	O	O
Terric Borosaprist			N	N	O	R
Typic Cryosaprist			O	O	O	O
Lithic Cryosaprist			N	N	R	N
Terric Cryosaprist			N	N	O	R
Typic Medisaprist			O	O	O	O
Fluventic Medisaprist			R	O	O	O
Limnic Medisaprist			N	R	O	O
Terric Medisaprist			N	N	O	R
Terric Troposaprist			N	N	O	R

DISCUSSION

The subsidence classes developed in Louisiana were discussed. Subsidence, as used here, refers to the total effect of all processes that result in reduction of peat thickness, including compaction and oxidation. Although the criteria appear to be satisfactory for California, it was suggested that further study is needed to develop criteria for Histosols in colder areas. There are few, if any, drained peat soils in such areas in the western region.

Keys similar to those for the Histosols have been developed for several orders. They appear to be more helpful to experienced soil surveyors than to students.

It was recommended that the Committee on Histosols be continued.

The report was accepted by the Conference.

NATIONAL COOPERATIVE SOIL SURVEY

Western Regional Conference Proceedings

Las Cruces, New Mexico
January 26-29, 1970

Proceedings

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

Las Cruces, New Mexico
January 26-29, 1970

REPORT OF CONFERENCE PROCEEDINGS

The Western Regional Technical Work Planning biennial meeting was held in Las Cruces, New Mexico, on the campus of New Mexico State University, January 26-29, 1970.

After registration, announcements and introductions, Dr. A. A. Baltensperger, Head of the Agronomy Department, New Mexico State University, welcomed the [illegible] come to Las Cruces. It was also noted that the opportunity to observe and study soils in Hawaii would contribute greatly to the overall knowledge of soils by soil scientists of the group. As a result of the discussion, the group voted to accept the Hawaii invitation but also chose Tucson, Arizona. as an alternate location.

The Thursday afternoon session began with Committee 9 - Soil family criteria report. This was followed by a discussion by John E. McClelland, Principal Soil Correlator, Lincoln, Nebraska, on Soil Temperature and Moisture Parameters Affecting the Soil Classification System. After the report by Committee 10 - Handling soil survey data, J. M. Williams summarized the conference. It was then adjourned.

COMMITTEE MEMBERSHIP ASSIGNMENT
WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
FOR SOIL SURVEY
LAS CRUCES, NEW MEXICO
JANUARY 26-30, 1970

Committee 1 - Application of the new soil classification system

L. D. Giese, Chairman
K. E. Bradshaw
O. V. Chenoweth
T. B. Hutchings
R. C. Kronenberger
H. Sato

Committee 2 - Soil structure and fabric

E. M. Richlen
S. Rieger

Committee 9 - Soil family criteria

Committee 10 - Handling soil survey data

10:00 - 10:15
10:15 - 10:45
10:45 - 11:15
11:15 - 11:35
11:35 - 11:55

Dr. Guy Smith

1:15 Bus leaves the Mission Inn for afternoon field trip.

THURSDAY A.M. JANUARY 29   J. A. Williams, presiding

8:30 - 9:40 Report of Committee 7
9:45 - 10:00 Coffee
10:00 - 11:45 Report of Committee 8
11:15 - 12:00 Business meeting

THURSDAY P.M. JANUARY 7.9   W. A. Starr, presiding

1:15 - 2:30 Report of Committee 9
2:30 - 2:45 Temperature and Moisture Parameters Affecting the Soil Classification System - Dr. J. E. McClelland
2:45 - 3:00 Coffee
3:oo - 4:15 Report of Committee
4:15 - 5:oo Conference Summary - J. M. Williams

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY
LAS CRUCES, NEW MEXICO
JANUARY 26-30, 1970

REPORT OF COMMITTEE 1
APPLICATION OF THE NEW SYSTEM OF SOIL CLASSIFICATION

The Conference Steering Committee assigned the following charges to this Committee:

1. Complete assignment of criteria used to differentiate series within families.

2. Proposed criteria for naming mapping units at the family or higher categories.

These charges represent unfinished business of the last regional committee on this subject. The last regional committee functioned as a working committee for sometime after the last conference. The Principal Soil Correlator provided the committee with summary sheets showing distinguishing characteristics of soil series within most of the larger families in the western states. T. B. Hutchings, past chariman, and members of his committee, in cooperation with state correlators, examined the series within each of the families and listed the characteristics used to distinguish between the series within each family and the frequency with which each characteristic was used.

The past committee found that generally series separations within families were based on a combination of two or more factors. Seldom was sepration based on a single factor. Color, texture of the control section, coarse fragment content, calcium carbonate content, depth to bedrock or contrasting materials, thickness of solum, structure in the control section, end reaction were used most frequently in differentiating between series within the same family.

The last regional committee provided the following summary of their analyses of the factors used in differentiating series within the same family and the frequency with which each factor was used.

Factors Separating Series Within Families (numbers indicate frequency):

Typic Xerochrepts - coarse-loamy, mixed, mesic family*
- Texture of control section
- Depth to bedrock
- Color value

Typic Vitrandepts - ashy, mesic family
- Moisture regime
- Texture of control section
- Depth to bedrock
- Buried Be horizon

Typic Vitrandepts - cindery, mesic family
- Moisture regime
- Mollic epipedon
- Mineralogy
- Texture of control section
- Reaction
- Thickness of sola

Typic Cryochrepts - coarse-silty. mixed family

Texture of control section	1
Depth to bedrock	2
Reaction) Base saturation)	4
Ash deposit (mineralogy)	3

*Clasification as of January 1968

Dystric Cryandepts - thixotropic family

Incipient horizons	1
Thickness of Al horizon	1
Mineralogy (ash)	1

Typic Torriorthents - coarse-loamy, mixed, calcareous, mesic family

Texture of control section	3
Soil moisture regime	4
Color	1
Reaction	1
Depth to contrasting material	2
$CaCO_3$ content	1

Typic Argiustolls - fine, montmorillonitic, mesic family

Depth to bedrock	1
Calcic horizon less than 20"	1
Calcic horizon more than 20"	1
Color	1

Typic Haplargids - fine-loamy, mixed, thermic family

Depth to bedrock	1
Thickness of solum less than 20"	1
Thickness of solum more than 20"	11
Calcic horizon	8
Ca horizon	4
Carbonate content (profile)	3
Coarse fragments less than 15%	9
Coarse fragments more than 15%	3
Color of control section	12
Percent sand in control section less than 50%	2
Percent sand in control section more than 50%	9
Salinity	1

Typic Calciorthids - coarse-loamy, mixed, mesic family

Coarse fragments	2
Color	2
Parent materials	1
Texture of control section	1
Reaction	2
$CaCO_3$ content	3

Typic Haploxerolls - coarse-loamy, mixed, mesic family

Soil depth	6
Coarse fragments	10
Color	7
Parent materials	5

Typic Argixerolls - fine, montmorillonitic, frigid family

Soil depth	3
Coarse fragments	5
Color	14
Parent materials	4
Texture of control section	2
Solum thickness	4
Reaction	3
$CaCO_3$ content	1
structure	1

Calcic Argixerolls - fine-loamy, mixed, mesic family

Coarse fragments	4
Color of control section	6
Texture of control section	7
Solum thickness	3
Reaction	4
$CaCO_3$ content or depth to carbonate	4
Structure	3
Moisture regime	7
Depth to contrasting materials	5

Typic Hydrandepts - thixotropic, isothermal family

Texture	16
Structure	12
Consistence	11
Depth to bedrock	9
Presence of Ol horizon	7
Reaction	1

Typic Dystrandepts - ashy, isomesic family

Texture	5
Structure	7
Consistence	5
Chroma (OM content)	3
Coatings	5

Typic Haplumbrepts - fine-loamy family

Soil depth	3
Color	2
Parent materials	4
Reaction	2
Solum thickness	3
Drainage	1

Calcic Haploxerolls - coarse-loamy, mixed, mesic family

Soil depth	3
Parent materials	3
$CaCO_3$ content	3
Coarse fragments	3
Color	5
Texture	3
Drainage	2

Factor Evaluated	Frequency
Color	60
Texture of control section	47
Coarse fragments	42
Calcium carbonate content	38
Depth to bedrock or contrasting materials	35
Thickness of solum	28
Structure in control section	26

Factor Evaluated (Continued)	Frequency
Reaction or base status	24
Mineralogy	19
Consistence	16
Percent sand	9
Organic horizon	7
Coatings	5
Drainage	3
Salinity	1
Buried Bt horizon	1
Mollic epipedon	1

In addition to the factors used to differentiate series within the same family reported by the lest committee, the following were reported by this committee:

In fine families, silt-sand ratios
Size of coarse fragments--less than 10 inches and more than 10 inches
Calcareous vs. noncalcareous
Kind of underlying rock
Lamellae in B2t horizon
Thickness of horizons
Diagnostic horizons when not recognized at higher levels--calcic, gypsic, cambic, albic
Silica pans
Clay content in fine families--less than 50 percent end more than 50 percent
Glacial till vs. other mixed unconsolidated material
Hard fragments and soft fragments

The committee feels that all of the characteristics listed above may be valid criteria for distinguishing between series within the same family. This, of course, depends upon the combination and degree of expression of other characteristics.

The committee considered possible alternatives for naming mapping units at the family level. These included:

1. Using the name of an important series within the family.

2. Using the complete family name, i.e. 'Ashy over loamy-skeletal, mixed, frigid Typic Vitrandepts."

3. Developing a systematic nomenclature to identify families.

The first two alternatives have been used to date. The first alternative was used in Hawaii under the 1938 sail classification system. This worked out very well. Plantation people, University research scientists and other technical people accepted it and found it very useful. Most of the soil research in Hawaii is based on soil families named in terms of an important series in the family within the 1938 soil classification system. The soil families in Hawaii under the new system of classification do not coincide with the previous families. This is causing confusion among users of soils information. However, this problem can be expected under these conditions. This is probably the only case in the country where this situation exists.

Alternative "2" was used in the Central Lahontan River Basin Survey (Nevada and California) and all reports indicate that it is working quite well.

The committee has no experience or suggestions on alternative "3".

The committee did not agree on which alternative is best. All members did agree that there are advantages and disadvantages in using any one of the alternatives. It also agreed that until a standard system is agreed upon and adopted nationally, either alternative "1" or "2" may be used depending on the preference of chose making and using the particular survey.

The committee agrees that mapping units above the family level should be named in terms of the classification system such as Mollisols, Ustolls, Haplustolls, or Typic Haplustolls.

The committee agrees that the use of phases in the names of mapping units of families and higher categories can closely parallel the use of phases of soil series. For example, a slope phase of a family could be a subdivision of the family based on differences in slope that are significant to man's use or management of the soils in the family. Phases can be used at any categorical level.

Conference adopted committee report.

Conference approved continuation of committee with charges to be assigned by next conference steering committee.

Notes on Discussion During Presentation of Committee Report:

Giese - Montana separates series in Argids with IO-inch solum from those with more than IO-inch solum.

Cline - Wyoming and Colorado use 15-inch solum thickness rather than 10 inches to separate series. B3ca is considered part of solum. If solum is less than 15 inches thick, plowing will not leave enough of solum to be recognized. Difference between Montana and Wyoming and Colorado is one of definition more than anything else.

Mogen - I've seen fields plowed to depths of 8 inches far 20 years that still retained clayey peds of the B2t horizon within the Ap.

Smith - If solum is chin and argillic horizon is obliterated by plowing, there is no argillic horizon.

Link - Thickness of solum seems to be a local problem.

Smith - Let principal correlators get together and settle it.

Calcareous vs. noncalcareous solum:

Hutchings - Problem is the amount of lime that would be detrimental to craps. With more than two percent lime there is evidence of problems with phosphate availability.

Simonson - Maybe more than

Committee members:

WESTERN REGIONAL TECHNICAL WOW-PLANNING CONFERENCE

OF THE

COOPERATIVE SOIL SURVEY

Las Cruces, New Mexico
January 26-30, 1970

Report of Committee 2
Soil Structure and Fabric

Two charges were given to the committee:

1. Consideration of the criteria for identifying cambic horizons.

2. Consideration of the essentiality of clayskins es diagnostic features of argillic horizons.

In addition. the effects of cicada nymph burrows in soils were discussed end the relation of soil structure to permeability class is suggested for investigation.

Criteria for Identifying Cambic Horizons

The cambic horizon (5) is formed by alteration of parent material in place, hut not by illuviation. It is located immediately below one of the diagnostic epipedons, or et the surface if there is no A_1 horizon. The cambic horizon must extend at least 25 cm below the surface, hew textures of loamy very fine send or finer, and contain some weatherable minerals. It is delimited as not meeting the criteria for the other diagnostic horizons, fragipans or duripans. Evidence of alteration is expressed by one of the following forms:

1. Dominantly gray colors immediately below an umbric or mollic epipedon or within 50 cm of the surface on ped feces or in the matrix if peds are absent.

2. Stronger chromas or redder hues then the underlying horizons.

3. Evidences of remove1 of carbonates. Particularly. the cambic horizon shows less carbonate than the underlying ca horizon.

In addition, et least half the volume contains no rock structure (including fine stratifications of unconsolidated sediments).

Discussion

1. Soil structure is generally a characteristic of the cambic horizon end is normally expected to develop in place of rock structure ""less the texture is too coarse. However, absence of rock structure rather then presence of any form of soil structure is the criterion stated in the summary of characteristics (5, p.27). A question might be raised whether paragraph 4 under "Features common to cambic horizons" needs changing to conform with the change in item 2 of the summary. However, confusion on this point seems unlikely. and it is vell to emphasize the usual presence of soil structure.

2. Soil structure, combined with absence of rock structure can be the only criterion for the cambic horizon if carbonates are absent from the parent materials (5, paragraph 2, p. 27). Thus, soil structure alone is definitive criterion in some soils, but in others with similar structure but calcareous, it is not.

3. The definition of the cambic horizon includes the statement (5, paragraph 1, p. 27) that "carbonates have been redistributed and partly or completely removed as evidenced by solution pitting of limestone pebbles, end by the presence of an underlying horizon containing much larger amounts of carbonates that the soil morphology shows have been reprecipitated in the soil."

A more specific statement such as the following might be useful for the part underlined above, if for some reason the cambic horizon cannot include some horizons of maximum carbonate accumulation as discussed below. "--an underlying horizon containing a macroscopic accumulation of carbonates--".

However, this question could be raised. why cannot horizons of maximum carbonate accumulation with too little carbonate for the calcic horizon (15% or less $CaCO_3$ equivalent) be included in the cambic horizon and the soils (where lacking other diagnostic horizons that would take precedence, such as argillic horizons) be designated Camborthids? The cambic horizon already includes horizons with accumulations of illuvial clay that are too slight for the argillic horiro", as well as horizons with some carbonate above the horizon of maximum accumulation in Calciorthids end Paleorthids. Why not expand the definition of the cambic horizon to include horizons of maximum accumulation that arc too slight for a calcic horizon? This would Increase the pedogenic territory occupied by the Camborthids, and would remove some soils with distinct pedogeoic horirons from the Entisols.

4. The restrictions in definition of cambic horizons lead to some rather arbitrary distinctions between similar sails. Some ramifications resulting from the cambic horizon definition are: a) Some soils with evidence of pedogenesis are placed in the Entisols because they are too coarse-textured. Others do not qualify as Camborthids because horizons of ❑ aximvm carbonate are too shallow (less than 25 cm). b) There are relatively few Camborthids because many soils with cambic horizons have underlying calcic or petrocalcic horizons or duripans within 1 m of the surface. c) Soils having parent material colors with chromas of less than 2 may be Inceptisols if wattled. Other mottled soils may be Entisols.

The committee has no specific recommendation other than that the discussion above be considered in future revisions of the criteria.

The Essentiality of Clay Skins as Diagnostic Features of Argillic Horizons

Oriented clay skins on ped surfaces end in pores accompanied by a clay increase in the B horizon are the best indicators of illuvial clay accumulation under many conditions. However, under certain conditions, the identification of illuvial clay as clay skins is not possible. Also, the field identification of clay skins has sometimes not been substantiated by subsequent thin-section observations.

Listed below are some portions of the criteria for the argillic horizon (5) with reference to clay skins:

1. Massive soils - require bridging of oriented clays between sand grains and in some pores.

2. Soils with peds - oriented clays in 1 percent or more of the cross section are sufficient evidence of illuvial clay with or without clay skins present. Thin sections are needed to confirm this.

3. Clay skins may be absent if the illuvial horizon is clayey with 2:1 lattice clays provided there is evidence or pressure by swelling and there are uncoated sand or silt grains in the overlying horizon.

Discussion

Recent studies (1) (2) (4) have indicated that horizons of clay accumulation in soils of the desert regions generally do not show clay skins present on ped surfaces. The sandy soils are often massive with oriented clay present as bridging and coatings between and around sand grains. Distinct coatings of oriented clay on sand grains and pebbles are characteristic of the argillic horizon in these dry regions. Maximum expression of the oriented coatings in the clay maximum is take" as evidence of illuviation.

Clayey soils with montmorillonitic clays. considered to have Bt horizons, have been observed under thin section to lack clay skins. The recent paper by Nettleton, et al. (4) suggests that stress due to shrink-swell from moisture changes co" destroy illuvial clay coatings.

The committee concludes that criteria for the argillic horizon are adequate to allow soils without clay skins but that have other evidence of illuvial clay, to be placed in appropriate classes that reflect their genetic development. Possibly some soils that are genetically like Inceptisols may also meet these requirements for the argillic horizon.

Effects of Cicada Numph Burrows on Soils

Cicada nymph krotovinas have been reported in soils of Idaho. Utah. and Nevada (3) and have been observed in Montana, Oregon and in paleosols in New Mexico. Soils in a" arid or semiarid climate with good drainage, deep, silty textured profiles end low bulk density were reported by Hugie end Passey (3) as favored habitat for cicada nymphs.

The filled burrows in soils are composed of material similar to the horizon matrix in which they occur. but some analyses suggest they have a greater content of available P. The krotovinas generally appear as cylindrical peds 0.5 to 1.5 inches long and 0.3 to 0.75 inches in diameter (3). Roots and moisture movement have been observed to be concentrated around the sides of the burrows. The structural units often become cemented with carbonate (Idaho and Utah) or silica (Oregon), and form hard-in-place zones more resistant to disturbance than overlying or underlying layers. and generally between 12 and 30 or 40 inches in depth. These nodules have been called durinodes when cemented with silica.

The committee feels that some official designation is needed far describing these structure1 units. "Cylindrical blocky" structure with grades and classes as stated for angular and subangular blocky in the Soil Survey Manual (USDA Agr. Handbook 18. 1951) was suggested by Hugie and Passey (3). The committee recommends that "cylindroid" be substituted for "cylindrical blocky" and these burrow fillings should be treated as special features of soil horizons. Consistence should also be reported for these cylindroids.

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The committee suggests that investigations are needed on:

1. Relationships between soil structural morphology, texture and permeability.

2. Development of standards for determining soil permeability classes by field tests.

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Committee

C.H. Simonson, Chairman
L. H. Gile
A. R. Southard
F. F. Peterson
C. A. Nielson
P. C. Singleton
G.

Comments about "horizons and cambic horizons at-e in many cases more nearly complaints about the definition of the calcic horizon. At this time. reopening discussion of the calcic horizon is not appropriate.

S. Reiger: (With regard to recognition of cambic horizons). The minimum lower boundary depth requirement for cambic horizons should be dropped for cryic soils.

M. Fosberg: (With respect to terminology for cicada burrow fillings). Some soils are found far which cylindroids compose the major structural expression. Structural terminology is needed in addition to being handled under special features.

G. "ehara: With respect to correlating soil structure end permeability). Grade is the structural parameter which best correlates with permeability within limited groups of soils. Grade, sire, shape. and arrangement of structrual units are the morphological parameters available for attempting to predict permeability. The missing parameter is stability of pores; this might beat be estimated from COLE.

K. Flach: Measurement of permeability is properly a field problem to be done by field personnel.

G. Simonson: We need to redefine permeability in terms of field-applicable criteria.

C. "ehara: The soil physicists are now recognizing the need far "ball park values" and may be ready to consider field problems in the near future.

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
Las Cruces, New Mexico, January 26-29, 1970

Report of Committee # 3 "Soil survey 0" Range and Forest Soils."

The reports of the previous committee on "Soil Survey on Range and Forest Soils", and of the national committee on "Forest Soils" were reviewed by the committee chairman. From items mentioned in these reports the following subject item outline was developed and sent to members of the committee for comments, suggestions and a request far additional items.

1. Scale of maps to be used in field work and in published soil surveys.

2. Intensity of mapping and details of investigations.

3. Kinds of mapping units.

4. size of mapping units.

5. Mapping unit descriptions.

6. Interpretations.

7. Is there a need for better communications between soil scientists, faresters and range conservationists? If so how can this best be accomplished.

A copy of the outline was also submitted to the conference chairman, James Anderson. Dr. Anderson suggested that the committee also consider and evaluate some recent published soil surveys dealing with range and forest soils noting (1) adequacy of the surveys and (2) suitability of the reports for soil scientists and other users. Dr. Anderson's suggestion became item No. 8 on the subject outline. No other items were recommended by committee members.

1. Scale of maps to be used in field work and in published soil surveys.

The committee agreed that the scale of maps for use in field work and published soil surveys o" range and forest soils will vary with the complexity of the area. The most commonly used and preferred scale seem to be 2 inches = 1 mile or 1:31,680 for reconnaissance surveys and 3.16 inches = 1 mile or 1:20,000 for detailed surveys (low and medium intensities). Some committee members expressed a strong perference for 4 inches = 1 mile or 1:15,840 for field work on detailed surveys. A few members of the committee indicated they are using 1 inch = 1 mile or 1:63,360 scale maps satisfactorily for reconnaissance surveys. Most of the committee agreed that maps at a scale smaller than 1 inch = 1 mile are not justified for field work or for publication of soil surveys. Although it was recognized that smaller scale maps are useful for general soil maps, interpretative maps and broad planning. Since many of the new U.S.G.S. maps will be 7 1/2 minute quadrangle sheets at a scale of 1:24,000 or 2.64 inches = 1 mile possibly this should be give" additional consideration for soil survey work.

2. Intensity of mapping end details of investigation.

The majority of the committee indicated a strong preference for medium intensity survey on range and forest soils. They expressed a need for detailed information to provide adequate data to meet the increased demand and uses far soils surveys in reforestation. range and forest rehabilitation, range seeding, mechanical treatment of watershed, wildlife forage, engineering properties of soils and recreational site developments. Some members of the committee expressed that low intensity surveys will provide adequate information far most uses. A few members of the committee indicated a definite need for reconnaissance surveys to serve a pressing need for information on broad areas.

Since medium intensity surveys cost little more than low intensity and furnish considerable more information, the committee recommends medium intensity soil surveys for most range and forest areas, but recognize the need for both low intensity and reconnaissance surveys.

Special studies and investigations are needed in connection with most surveys to provide accurate information and adequate data for sail classification, useful interpretations and production.

Some members of the conference asked for definitions of medium, and law intensity surveys. Dr. Guy Smith indicated that SCS Soils Memo - 3 was cancelled and that we should think only in terms of detailed surveys and reconnaissance surveys.

In discussion it was pointed out that in survey of forest and range lands we do not always see a soil boundary throughout its full extent. Thus it might be considered that many of the so called detailed surveys on such lands may be at best low intensity.

3. Kinds of mapping units.

The committee is fairly well in agreement that in medium and low intensity surveys on range and forest soils mapping "nits should be phases of series or combination of phases of series. Surveys are most useful when natural landscape units are delineated and described in terms of series, phases or series, associations or complexes as may be pertinent.

A few members of the committee expressed a preference for mapping units at the family or subgroup level particularly on reconnaissance surveys. The mapping at high levels seems to work best (1) where detailed information is lacking but there is a pressing neeed to get published the knowledge that is available or (2) where it is necessary to get some general information about a large area. Soil classification nomenclature is not generally used in naming of mapping units above the series level. Descriptive terminology is used such as "steep, shallow, stony, medium textured soils on basalt". Subgroup, great group and family names have been used to a good advantage in a few surveys.

4. size of mapping units.

The question of minimal size of delineations to separate in mapping range and forest soils has been raised frequently. Is it better to delineate small areas on the map or merely describe them as inclusions7 Often small areas tend to clutter up the maps and give little information that is useful in range and watershed management. On the other band many small areas are highly contrasting in some characteristics to the adjacent soils and have very different capabilities, qualities, and interpretations. Very small areas of rangeland or forest lands sometimes have importance beyond their size.

The minimal size delineation that can be show clearly cartographically varies with map scale. The relative importance of the small area to the entire area maybe significant or of little value. A small area that has little value for one use or interpretation maybe important for a different use or interpretion.

The committee considered these questions and agreed that if is difficult to assign a definite quantative figure to the minimal size of delineation to be shown in mapping range and forest soils. The majority of the committee indicated that areas smaller than 10 acres are not generally delineated in mapping range and forest soils at medium intensity. Areas smaller than 100 acres are not generally delineated at low intensity. While 640 or 1000 acres may be a reasonable minimal size delineation on reconnaissance surveys.

In summary, the minimal size of delineation should depend on map scale, intensity of mapping, objectives of the survey, degree of contrast with adjacent soils and the relative importance of the small areas.

5. Mapping unit descriptions.

The previous western states committee developed a list of characteristics and associated features to be included in the descriptions of mapping units. The national committee agrees with the suggested list of characteristics to be included in a mapping unit description far range, forest and other wildland areas.

The present committee does not propose to alter the previous recommendations but would emphasize the need for quality descriptions that give standard profile descriptions, supplementary data and information for the required interpretation. Many of the descriptions in published soil surveys do not give adequate information and data for current needs in regard to runoff characteristics, infiltration rates, permeability, water holding capacity, sediment yield. present and potential erosion. geologic hazards, chemical and mechanical properties and surface condition.

Some committee members favor putting as much as possible for soil descriptions and data in tubular form.

A significant question raised - How can different kinds of unstable land best be recognized, described and classified? For example, how much detail should be shown in mapping slips and slides? Should slide hazard be show" with erosion hazard, etc?

6. Interpretations.

To be most useful published soil surveys should give interpretations and potential uses of soils or provide sufficient data and information so that the needed interpretations can be made. Different agencies have varying ways of grouping soils for interpretations to meet their particular needs. This is not a major problem providing adequate information is give" in mapping unit descriptions or soil grouping descriptions to provide for interpretations.

Generally soils have bee" grouped into capability units, range site and woodland suitability groups. All of these are not made nor are they needed in all published soil surveys. Often needed groupings for wildlife habitat types, sediment production, engineering and recreational potential are not give".

The committee generally agrees that interpretations can best be made at the taxonomic unit level. Associations require interpretation by components as well as some by whole units. Sow members of the committee suggested that descriptions of capability groups or other interpretative groups be expanded to include more information that is helpful in management, gives potential for reseeding or reforestation, gives density of dominant forest vegetation and detailed site production, shows potential for use under present conditions, gives response to mechanical and chemical treatments. and information on soil stability, sediment yields etc.

7. Communications.

The committee is in full agreement that there is a need for better communications between soil scientist and range conservationists, foresters and other map users and also between agencies. All members seem to agree that improvements in communication have bee" made during the last few years.

Several items are recommended that might help overcome the communication problem. These are (1) joint participation in field work during the beginning and throughout the course of the survey, (2) working together in making practical interpretations that can be utilized in the field, (3) training schools for foresters, range conservationists and other soil map useres, (4) continual effort on the part of the soil scientist to communicate with scientists in other disciplines, (5) educational institutions provide for early communications between students of the various disciplines, (6) additional coordination at higher levels within our Service and between agencies.

8. Adequacy of soil surveys and suitability of reports for soil scientist and other users.

Not all members of the committee responded to this item. However

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR SOIL SURVEY

Las Cruces, New Mexico January 26 - 29, 1970

REPORT

Committee Number 4

Climate in relation to soil classification and interpretation.

Committee activity:

In response to a questionnaire to all committee members on May 15, 1969, the replies indicated primary concern was for climatic criteria used in soil classification and their implications with respect to lend use interpretations. The replies were summarized and circulated to the committee for general discussion on September 11, 1969. A draft report was developed and circulated January 9, 1970.

The following charges have been acted upon by the committee:

1. Regional committees take the leadership in assembling the soil temperature data onto a standard form . . .

   With the assistance of J. M. Williams, soil temperature data from the region has bee" assembled by the committee and copies are in the hands of the chairman. he data received to date is quite extensive, as follows:

	Multiple dates	Single date
Alaska	11	
Arizona		88
California	162	
Colored"	219	13
Hawaii		11
Idaho	175	
Nevada	21	
New Mexico	65	
Oregon	80	
Utah	25	
Washington	85	
Wyoming	65	
Total	908	Total 112

Considerable data is also available for Montana but was not sent to the committee.

This data is in various stares of organization, and requires tabulation in a uniform manner for analysis. In order to accomplish this, the committee prepared an IBM data sheet format which was revised after discussion by the Conference (Appendix 1). However, this is a" immense amount of data, and hopefully the various states will share in the jab by transcribing their own data onto the IBM sheets for key-punching.

This is made necessary by the fact that much of the data lack complete site information which should include thickness of the O-horizon, slope, aspect, crop or vegetative cover, surface texture and drainage class; plus ocher sampling data such as moisture at time of sampling and where possible the mean air temperature of the month of sampling estimated from weather bureau data.

However, with this amount of data, analysis should provide highly reliable prediction equations for estimating soil temperature at any site.

2. A second charge involved the use of a standard form for recording soil temperature. This form has been used by several states, and where the form was used, the data is in good shape for coding for computer analysis; those states where it was not used appear to have often failed to record all the necessary site and moisture parameters necessary for

the analysis.

3. A third charge is to prepare a report which is fulfilled herewith.

4. A fourth charge was to encourage soil temperature readings during the summer months in addition to the four seasonal measurements. Six states have included regular monthly summer date.

5. A fifth charge recommended that soil moisture be recorded where it is pertinent to soil classification. Pour states have complied, being those who have generally used a standard form for recording data.

6. The sixth recommendation was that further testing be done to relate soil moisture regime estimates from climatic data to soil moisture measurements. Apparently little has bee" accomplished along these lines, although the soil moisture conditions recorded at the time of temperature measurements could be analysed rather qualitatively for this purpose. Utah data includes moisture contents which might be subject to quantitative analysis.

   I" order to obtain the data necessary to accomplish the objectives of this charge, it is clear that a more systematic program of date collection is required. I" order to make most effective use of soil moisture dare, it should be planned so that the soil moisture regime can be related directly to climatic measurements; thus soil moisture data should be collected et or "ear weather stations.

   It has bee" suggested that a program of soil moisture measurement along a series of transects throughout the west might be ● eteblished, with some degree of co-ordination across state lines. Such a program might be arranged es a project of the Western Regional Work Croup under the Western Regional Soil and Water Research Committee.

   Moisture measurement on such a project should extend over a period of several years, end presumably the use of a neutron probe coupled with a limited amount of soil sampling and gravimetric moisture determinations for calibration purposes would be satisfactory.

   Such a program would simultaneously provide benchmark soil moisture information for soil classification and data which could be used to improve the present methods of estimating the water balance end soil moisture regime from climatic data.

   I" the discussion at the conference K. Flach suggested that the moisture studies should include soil genesis studies. This would complicate the investigation, end there was no definite conclusion reached on this subject.

Other considerations:

The question has been raised "Is the 47° isotherm a valid separation for a climatic limitation of certain crops?" It has been pointed out that the length of growing season does not necessarily parallel the 47° isotherm in Wyoming. Similar soils in mesic families in Wyoming, southern Colorado end northern New Mexico sustain entirely different cropping patterns. The committee would appreciate the comments of the conference on the relevance of the 47° boundary for classification of soils. Discussion of this point indicated that, in spite of some problems, no change in this limit should be recommended.

The following statement has bee" submitted by L.R. Wohletz concerning the potential evapotranspiration map of the "ester" United States (PET 32%).

Information on both soil temperature and soil moisture regimes See needed for both soil classification end soil interpretations. During the last 10 years the eleven western states have calculated the potential evapotranspiration for frost free season (PET 32°F) along with other parameters for all climatic stations, based on formulas developed by Thornthwaite (1948).

The calculations were made by the state soil scientists working variously with the state experiment stations end the state climatologists. Several states published the data for their state.

In 1967 en ed hoc task force appointed by the Coordinated Planning Subcommittee, PSIAC, was requested to develop a regional PET 32°F map for possible use in river basin surveys. Accordingly, each of the western states prepared a climatic zone map et varying scales

SOIL TEMPERATURE DATA RECORD FOR AUTOMATIC DATA PROCESSING

Instructions for coding (or keypunching) data on IBM data sheets.

he date record for each site of measurement consists of:

1. Identification and site information. Line 1 or card 1 of a site record.
2. soil temperature, moisture and cover data on succeeding lines or cards. (The data for each calender year is recorded on a single line or card.) So the number of lines (or cards) for each site is one greater than the number of years of recorded data.

For convenience in checking the date sheets, a blank line should separate each complete site record. However, a blank card should not be inserted in the card deck.

Decimal points are not punched. Missing data should be left blank. X = leave blank.

SITE DATA. (First line or first punch card of each record)

Columns	Entry
1-3	Abbreviation of name of STATE. (CAL, ORE, IDA,NM, etc.)
4-5	COUNTY code number. (Number from alphabetic list of counties.)
6-D	SITE number within county. (Any three digit number, i.e., 001,197, etc.)
9-20	SERIES name. First 12 letters of soil series name, begin in Col. 9.
21-25	ELEVATION. Elevation in feet. Adjust right xx100, 10500, x7000, etc.)
27-30	LATITUDE. Record to nearest 15 minutes. (i.e., 3800, 3815, 3830, 3845, etc.)
31-35	LONGITUDE. Ditto/ (i.e., 13000, 13015, 13030, 13045, etc.)
38-40	SLOPE in percent. (i.e., 5% = xx5, 15% = x15, etc.)
45	ASPECT N - 1, NE - 2, e - 3, SE = 4, s - 5, sw = 6, W = 7, NW = 8
50	TEXTURE of surface soil. (Preferably upper 7 inches) Coarse skeletal 1; Coarse 2; coarse loamy 3; Coarse silty 4; Fine loamy 5; Fine silty 6; Fine 7; Very fine 8
54,55	Thickness of O-horizon. (OTHIK) in inches. (i.e., 02, 04, 22, etc.)
60	DRAINAGE class. Very poorly drained 1; Poorly drained 2; Somewhat poorly drained 3; Moderately poorly drained 4; Well drained 5; Somewhat excessively drained 6; Excessively drained 7
65	IRRIGATED? Not irrigated 1; Irrigated 2
69	MCLASS. Classification of soil with respect to moisture. Aridic 1; Xeric 2; Ustic 3; Udic 4
71-72	NYEARS. Number of Calendar years of soil temperature measurements. This number should equal the number of lines (or cards) following this SITE DATA line or card.
73-74	Record 01 (Card 1 of site record)

TEMPERATURE DATA. (One line or card for each calendar year of record.)

Columns

43

REPORT OF COMMITTEE 5 - CRITERIA, NOMENCLATURE AND CLASSIFICATION OF MADE. DISTURBED AND SHAPED SOILS

Committee 5 was given the charge to develop a key for the classification of Made land and Made soil. Such . key should:

1. Differentiate between Made land and Made soil

2. Separate classes on the basis of characteristics important to land use

The Committee has prepared definitions and . classification key to be given . trial in the Western States.

Definitions of ❑ iacellsneous land type. are adapted from reports of region.1 and nation.1 committee. Of previous years.

The proposed key is an attempt to classify Made land and disturbed or shaped soil. according to characteristics that can be observed in the field. Emphasis was placed on the nature and characteristics of materials, rather than on the method of deposition or placement of materials. Also, for reasonably uniform ❑ teri.,., soils should be classified at the series level end map units named as phases of soil series.

DEFINITIONS

Miscellaneous Land Types

Made land - consists of areas filled or covered artificially with ❑ iscell.neous material including trash, stones, and industrial waste. The ❑ iseellaneou. material may or may not be covered by earth material, but if covered. earthy material is leas than 20 inches thick. Phases for recognition of thickness of ● .rthy covering as well as the kinds of ❑ iecellsneous material may be used if needed for interpretation purpose..

Cut and fill land - consists of areas in which the soil or the soil and the underlying regolith has been greatly modified by appreciable removal in some places and comparable additions in others. Over the major part of an individual body, the cuts are deep enough to remove all or nearly all of the diagnostic horizons and the fills are thick enough to bury the original solum to depths of 20 inches or more. The pattern of cuts and fills is complex and

A PROPOSED KEY FOR CLASSIFICATION OF MADE LAND AND DISTURBED OR SHAPED SOILS

I. With less than 50 percent of earthy uteri.1 in the control Section, or with . cover of earthy uteri.1 less than 20 inches thick. Made land.

(Naming up unit. - If more than 200 acres, upping unit should be named "Made land" and described as a miscellaneous land type. If less than 200 acres use a special mapping Symbol. In most survey areas made land occurs in mull bodies that can be shown best by special symbols.)

II. With more than 50 percent of earthy material in the control section, and with. cover of earthy uteri.1 more than 20 inches thick.

A. Without fragments of diagnostic horizons, or if diagnostic horizons are present they have been interrupted in over 657. of area or are buried more than 20 inches deep.

1. With heterogeneous ● .rthy material having . wide range in textures,1/ other characteristics or both. Cut and fill land or Fill land.

(Naming map unite - modifier. to indicate the nature of the material may be added to the phrase "Cut and fill land" or "Fill land".)

2. With homogeneous earth material having . narrow range in textures, and without diagnostic horirons - Entisols. Classify at the lowest category possible. preferably at the series level.

(Naming map units) -

(a) Map units should be named as phases of soil series. Disturbance of such soils commonly will not change the soils appreciably, and they may be named the same as the original series.

(b) If an existing series cannot be identified. and the material Is extensive,. new series should be nsmed and described. Map units should be nsmed as phases of Soil series.

(c) If the material is not extensive. the soil may be named as a variant of an existing Series. Hap units should be nsmed as phases of the soil variant.

B. With fragments of diagnostic horirons. Original diagnostic horizons have been mixed by ripping, deep plowing, or other operations, but not to the extent that fragments or parts of horirons can no longer be identified or are burled more than 20 inches. Classify in the suborder - Arents.

No great groups or subgroups have been defined in Arents, but family nomenclature including texture, mineralogy, reaction, and temperature may be sdded to the classification.

(Naming map units) -

1. If the sails are uniform enough that most pedons have characteristics within the range of. series, name and define as a soil series. Map units should be named as phases of soil series.

2. If the soils are not uniform and pedons have characteristics that are too wide to be appropriate for. series, name the mapping unit at some level above the series category, using the suborder name, Arents, as part of the name.

1/ Strongly contrasting particle size classes in family groupings may be . guide for "wide range in textures."

(a) If the original roil series, before alteration, can be determined with . reasonable degree of certainty. the series name may be wed as part Of tht mapping unit name, if this will serve . useful purpose. Example: Argidic Arents, Elijah soil materials.

(b) If the original soil series cannot be identified, modifiers may be used to indicate the kind of diagnostic horizon. present and the general texture cl.... Example: Argidic Arents, loamy.

C. With diagnostic horizon. that have not been destroyed, or interrupted, over less than 35% of the area, or buried more than 20 inches. Classify in appropriate order. at the lowest category possible, preferable . . . phase Of . soil series.

(Naming map units) -

Name . . phases of soil series. Example: Elijah silt loam, leveled phase.

Recommendations by Committee

The Committee recommends that thi. key be given a trial in all states. Suggestions for revision should be sent to the Committee Chairman. The key will be revised if necessary, and presented at the next conference. At that time the Committee could be discontinued.

After . brief discussion this report was adopted.

Discussion

Most of the discussion was on the acreage limit of miscellaneous land type. that should be mapped with special symbols. There was general agreement that most areas will be small and should be shown on maps by special symbols. Mr. Williams pointed out that if areas are delineated then the land type must be named and described. Mr. Cline said that consideration must be given to the value of the land when deciding the minimum size area to delineate. Mr. James said that most areas of Made

Samples of how Fill land h.. been described in recent soil survey manuscripts have been provided by the Principal Correlator.

FILL LAND

Fill land is used . . . ● iaesll.ncou. land type in and around the urban areas of Vancouver, Camas, ● d Washougal, Washington. Large areas along the Columbia River water- front have been filled in by dredging of sand and silts from the river. These areas have then been smoothed. (Adapted from Soil. Handbook for Clark County, Washington • fin.1 correlation March, 1967.)

The mapping unit description also states that the areas are filled artificially with earth. trash, or both, and smoothed. No percentages of the component. are given, but we . ssume that the percentage of trash is relatively low. Otherwise, Made land would be more appropriate.

PILL LAND

Fill land consists of areas filled with material from dredging, excavation from adjacent upland., garbage, and bagasse and slurry from sugar mill.. This land typ. is mapped on Kauai, Maui, and Oahu.

Fill land (Fd). This land type consists primarily of areas filled with bag.... and slurry from sugar mill.. Per areas are filled with material from dredging and from soil excavations. For the most part, these uteri.18 are dumped and spread over marshes, low- lying areas along the coastal flats, coral sand, coral limestone, or sic.. shallow to bedrock. This land type is used mostly for the production of sugarcane.

(Land capability is variable.)

Pill land, mixed (FL). This land type consists of areas filled with material dredged from the ocean or hauled from adjacent areas, garbage, and general material from other sources. It include. . few areas that have been ● xc.v.ted. This land type is used for urban development, including airports, housing and industrial facilities. It is mostly near Pearl Harbor and in Honolulu adjacent to the ocean.

(Land capability is variable.)

(From Five-Island Are.. Hawaii - final correlation February, 1968.)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WEST REGIONAL TECHNICAL WORK PLANNING CONFERENCE
for
SOIL SURVEY
Las Cruces, New Mexico, January 26-29, 1970

Report of Committee 6 - Engineering Application and Interpretation of Soil Surveys

The charges given to the committee were as follows:

1. Propose uniform criteria for engineering interpretations of soils.

2. Develop a" outline for a guide book to engineering interpretations of soils for specialists in other disciplines.

The committee's recommendations and discussion for each of the charges are enclosed. We recommend that the committee be continued and that one of its charges be to prepare a draft of the guide book.

CHARGE NO. 1 - Proposed Uniform Criteria for Engineering Interpretations of Soils

Attached are 12 guide sheets proposed as uniform criteria for engineering interpretations 6f soils. They represent the combined thinking of many individuals. Most of these guide sheets will

SOIL LIMITATION CUSSES FOR SEPTIC TANK FILTER FIELDS

Soil Properties	Soil Ratings in Terms of Limitations		
	None to Slight	Moderate	Severe
Permeability class[1/]	Rapid[2/], moderately rapid, and upper end of moderate	Lower end of moderate	Moderately slow and slow[3/]
Hydraulic conductivity rate (Uhland core procedure)	More than 1.0 inch/hr.[2/]	1.0 to 0.63 inch/hr.	Less than 0.63 inch/hr.
Percolation rate (Post hole procedure)	Faster than 45.0 min./inch[2/]	45 to 75 min./inch	Slower than 75 min./inch
Depth to water table (seasonal or normal)	Over 6.0 feet below surface	4.0 to 6.0 feet Temporary seasonal water table	Less then 4.0 Normally high water table
Flooding hazard (frequency)	Not subject to flooding	Very seldom flood Not more often than once in 5 years	Subject to flood More often than once in 5 years
Slopes	0 to 5 percent	5 to 10 percent	over 10 percent
Depth to hard rack. bedrock, or other impervious materials	over 6.0 feet	4.0 to 6.0 feet	Less than 4.0 feet

1/ Class limits are the same as those suggested by the Work Planning Conference of the National Cooperative Soil Survey.

2/ Indicate by footnote where pollution to water supplies is a hazard

3/ I" arid or semiarid areas soils with moderately slow permeability may have a moderate limitation.

Discussion:

1. Greater depths to water table may be necessary in some soils to avoid contamination of ground water or nearby streams and lakes.

2. Many people feel that very rapidly permeable soils should be rated as having a sex? Ü6kita (tild cause (of)Tj ET q765.6000067 0 0 5.44000224496.32000715426.9600068 cm BI /W753 /H 21 /B

3.

4.

5.

SOIL LIMITATION CLASSES FOR LAGOONS

Soil Properties	Limitation Class		
	None to Slight	Moderate	Severe
Permeability	Less than 0.60 inch/hr.	0.63 to 2.0 inch/hr.	Over 2.0 inch/hr.
Depth to bedrock	Over 60"	40 to 60"	Less than 40"
Slope	Less than 2%	2 to 7%	over 7%
Reservoir site material (Unified grouping)	GC1/, SC, Cl and CH	GM1/, ML, SM and MH	GP, SW. SP, SW. Pt, OL, and OH
Coarse fragments, under 6" diameter, by volume	Less than 207.	20 to 507.	over 50%
Percent of surface area covered by coarse fragments over 6" diameter	Less than 3%	3 to 15%	over 15%
organic matter	Less than 2%	2 to 15%	Over 15%

Discussion:

One agency questions whether the presence of 15% surface cover of coarse fragments is really a severe limitation in view of the heavy equipment now used for construction.

1/ The GM and CC classifications would need to have more than 25 percent fines in order to be placed in these limitation classes. If they contain leas than 25 percent fines they will need to be rated as severe.

Organic matter content may not be a problem.

Permeability rates may be too permissive.

Soil Limitations for Sanitary Land Fill Areas

Definition: These areas are for underground burial of garbage and trash. The chief requirements are deep, well drained soils. The site should be free of flooding. The soil should be easy to excavate.

The ratings given are based on the sail profile to a depth of 5 feet. Geologic investigation of materials below this depth will need to be made on-site before final determination of the site-limitation can be made.

Soil Properties and Qualities	Degree of Soil Limitation: None to Slight	Moderate	Severe
Depth to hard rock	More than 5 feet	More than 5 feet	Less than 5 feet
Drainage class	Well drained, somewhat excessively drained	Moderately well drained. excessively drained	Somewhat poorly drained. poorly drained. very poorly drained
Depth to seasonal water table	More than 5 feet	More than 5 feet	Less than 5 feet
Slope	0-S%	8-15%	More than 15%
Stoniness	Nonstony or stony	Very stony	Extremely stony
Flood hazard	None	None	Any
Texture	Silt loam, loam, very fine sandy loam, fine sandy loam, sandy loam (percent by volume of gravel and cobble O-357.)	Sandy clay loam, silty clay loam, clay loam, loamy sand, sand (percent by volume of gravel and cobble 35-100%)	Clay, silty clay, sandy clay

Discussion:

California is using narrow canyons as disposal areas; and they question slope of the canyon walls a* a real limitation.

Pollution hazard should be a line entry on the guide.

SOIL LIMITATIONS FOR LOCAL ROADS AND STREETS

Items affecting use	Degree of Soil Limitation

1/

2/

3/

4/ PI means plasticity index.

5/

6/

Soil Limitations for Local Roads and Streets (cont'd)

Discussion:

Limitation ratings of moderate or severe due to stoniness or rockiness may need to be re-considered because of ease of moving the material with the heavy equipment now being used for construction.

Kind of bedrock greatly influences the ease of removal during road construction.

SOIL LIMITATIONS FOR POND RESERVOIR AREAS

Definition: Pond reservoirs are areas behind a dam or embankment where water is collected end stored for use. The floor of the reservoir area is normally undisturbed except where soil materiel may be borrowed for embankment construction. Construction material for embankments, however, is rated separately and is not a consideration for pond reservoir areas.

Soil Properties: Properties affecting pond reservoir areas are those that affect seepage rate; namely, soil permeability and depth to fractured or permeable bedrock or other permeable material.

Properties affecting use	Degree of Soil Limitation: None to Slight	Moderate	Severe
Permeability class (in./hr.)	very slow, slow (< .20)	Moderately slow. moderate (.20 - 2.0)	Moderately rapid through very rapid (> 2.0)
Depth to materiel with high conductivity	More than 6'	3 to 6'	Less than 3'

Discussion:

Several members of the conference felt that this guide sheet could be combined with the one for sewage lagoons.

SOIL LIMITATIONS FOR SHALLOW EXCAVATIONS

This guide applies to sail uses that require excavating or trenching to a depth of 6 feet or less. Such uses include underground utility lines (pipelines, sewers, cables), cemeteries, sanitary landfills, basements, and open ditches, although some supplemental criteria may be needed far pipelines, cemeteries, and sanitary landfills. For example, for pipelines, additional interpretations about shrink-swell potential and corrosivity may be needed; and, for cemeteries. additional interpretations about landscaping are needed. Most of the anticipated uses involve backfilling, but some, such as basements and open ditches, do not, Desirable soil qualities and characteristics are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops, and big stones, and no flooding.

Items affecting use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Soil drainage class	Excessive, somewhat excessive, and well drained soils	Moderately well drained soils	Somewhat poorly, poorly, and very poorly drained soils
Seasonal water table	Below 60 inches	Between 30 end 60 inches	Above 30 inches
Flooding	None	None	Subject to flooding
Slope	0-8%	8-15%	“ore than 15%
Texture of depth to be excavated 1/ 2/	fsl, 61, 1, sil, sic, scl	si 3/, cl, sc, all gravelly types	c 4/, sic 4/, s, ls, organic soils, a11 very gravelly types
Depth to bedrock?’	More than 60 in.	40 to 60 inches	Less than 40 inches
Stoniness (classes)/	0, 1	2	3, 4, 5
Rockiness (classes) 6/	0	1	2. 3. 4, 5

1/ Texture is used here as an index of workability and sidewall stability.

2/ If soil contains a thick fragipan, duripan, or other material difficult (but not impossible) to excavate with hand tools, increase the limitation rating by one class unless IL already is severe.

3/ If sail will stand in vertical cuts, like loess, reduce rating to slight.

4/ Ii friable, like that in some kaolinitic Paleudults, reduce rating to moderate.

5/ If bedrock is soft enough so that it can be dug out with ordinary handtools, reduce moderate and severe ratings by one class.

6/ See definitions in Soil Survey Manual, pp. 217-221.

Discussion:

Stoniness and rockiness may not present as severe a limitation as indicated by the guide. Heavy equipment used may greatly reduce the limitation.

SOIL LIMITATIONS FOR DWELLINGS [1/]

Item affecting use	Degree of Soil Limitation [2/]		
	None to Slight	Moderate	Severe
Soil drainage class [3/]	With basements: Excessively Somewhat excessively Well Without basements: Excessively Somewhat excessively Well Moderately well	With basements: Moderately well Without basements: Somewhat poorly	With basements: Somewhat poorly Poorly very Poorly Without basements: Poorly Very poorly
Seasonal water table	With basements: Below 60 in. Without basements: Below 30 in.	With basements: Below 30 in. Without basements: Below 20 in.	With basements: Above 30 in. Without basements Above 20 in.
Flooding	None	None	Occasional to frequent
Slope [4/]	0 to 8%	8 to 15%	More than 15%
Shrink-swell potential	Low	Moderate	High
Stoniness [5/]	Classes 0 and 1	Class 2	Classes 3. 4, and 5
Rockiness='	Class 0	Class 1	Classes 2. 3, 4. and 5
Depth to bedrock [6/]	With basements: More than 60 in. Without basements: More than 40 in.	With basements: 40 to 60 in. Without basements: 20 to 40 in.	With basements: Less than 40 in. Without basements: Less than 20 in.

1/ By reducing the slope limits 50 percent, this table can be used for evaluating soil limitations for shopping centers and for small industrial building with foundation requirements not exceeding those of ordinary three-story dwellings.

2/ Some soils raced as having moderate or severe limitations may be good sites from an aesthetic or use standpoint but require more preparation or maintenance.

3/ Soil Survey Manual, pp. 169-172

4/ Reduce slope limits 50 Percent far those soils susceptible to hillside slippage.

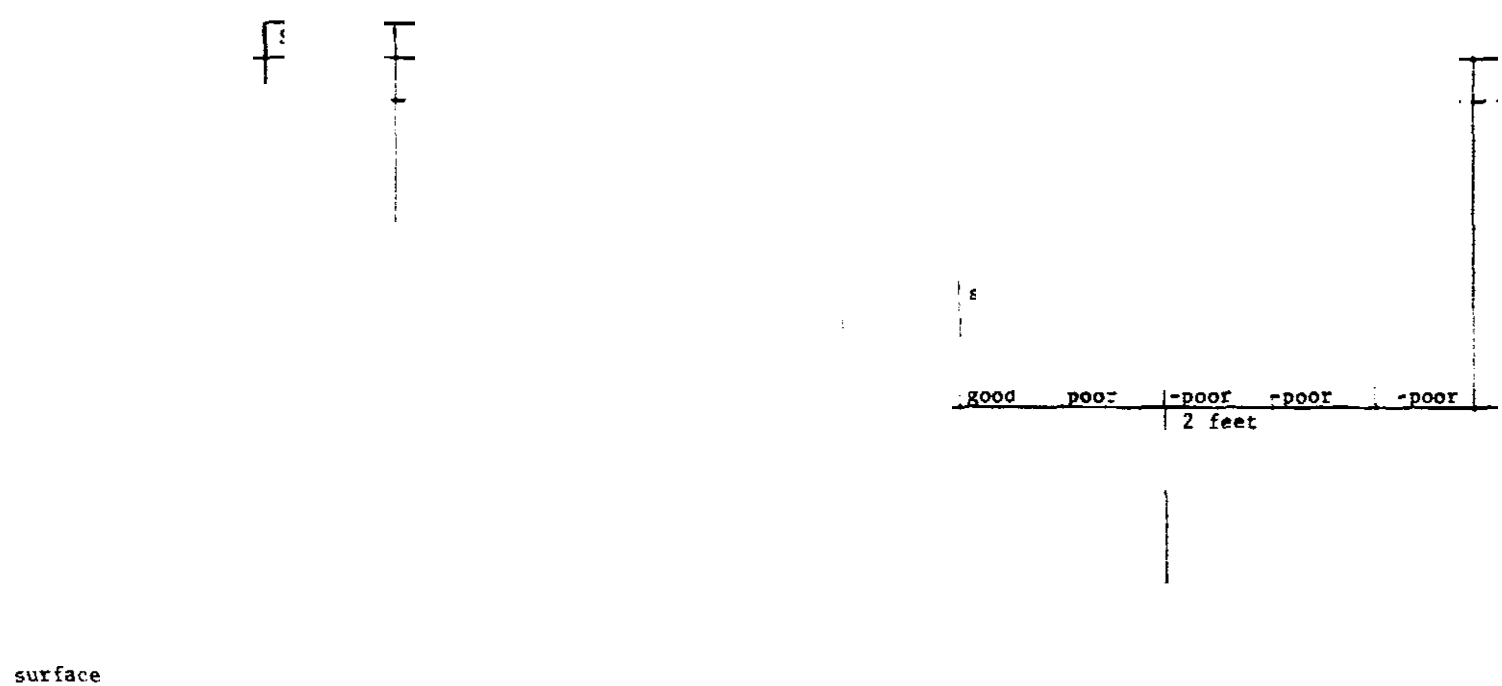
5/ Soil Survey Manual, pp. 216-223.

6/ If bedrock is soft enough so char it can be dug out with ordinary hand tools, reduce the moderate and the severe ratings by one class.

Soil Limitations for Dwellings (cont'd)

Ratings are for undisturbed soils that are evaluated for single-family dwellings and other structures with similar foundation requirements. Excluded are buildings of more

Discussion:


good
poor
-poor
-poor
-poor
2 feet
surface

SUITABILITY AS PROBABLE SOURCE OF SAND AND GRAVEL

DEFINITION: Ratings are based on the probability that soils contain deposits of send coarser than No. 200 sieve (.08 mm) or gravel coarser than No. 4 sieve (5 mm). The ratings da not indicate quality of deposits except [illegible] terms of grain sir;. The materials are commonly [illegible] ains, aggregate for concrete, or granular sub[illegible]. Roadfill (subgrade is rated separately els[illegible]

PROPERTIES: The property co[illegible] the soil and to a predictable depth [illegible] of sand or gravel are based on studies of the upper 4 to 6 feet of soil. Reliable predictions can be made to SO inches an many soils and to greater depths on some soils. Sieve sizes are reflected in Unified soil groups.

Properties Affecting Use		
Unified Soil Groups	GM, GP-GM GW-GM	

SUITABILITY AS A SOURCE FOR TOPSOIL

Definition: Topsoil is the soil material used to cover or resurface an area where vegetation is to be established and maintained.

Properties: Properties considered are those that affect the productivity and workability of the soil material and the amount of suitable material available. Soil texture and presence of toxic materiels gives an indication of the productivity of the soil material. An indication of workability as for seedbed preparation is given by texture and coarse fragments. For clayey soils, mineralogy is also considered. Thickness of suitable material and amount of coarse fragments affect the availability and ease of excavation of the soil material.

Properties Affecting Use	Suitability of soil: Good	Fair	Poor
Texture	fsl, vfsl, l, sil; sc where 1:1 clay is dominant	sl, si, cl, scl, sicl; sc where 2:1 clay is dominant; c and sic where 1:1 clay is dominant	s, ls; c and sic where 2:1 clay is dominant
Soluable salts--Conductivity of saturation extract (mmhos/cm)	Less than 4	4 - 8	More than 8
Exchangeable sodium (%)	Less than 5	5 - 15	More than 15
Calcium carbonate equivalent (%)	Less than 15	15 - 30	More than 30
Sulfur (%)	Less than 1.0 not class determining		More then 1.0
Thickness of suitable material	More than 20"	6 to 20"	Less than 6"
Fragments coarser than very coarse sand (%) by volume	Less than 3	3 to 10	More than 10

Discussion:

The engineers would like to see this rating removed from the engineering cables. They feel this is really an agronomy rating.

Several members of the conference feel that the percent organic matter and available water capacity should be line items in the guide.

SUITABILITY OF SOIL FOR ROADFILL

Definition: Roadfill is the soil material on which a subbase is laid and the pavement is built. Suitability ratings are based on the performance of the soil material when excavated and compacted or compacted and used in place. Proper compaction and drainage of the material are assumed.

Properties: Properties that affect suitability for roadfill are (1) those that affect the stability and traffic supporting capacity and (2) those that affect the ease of excavation of the borrow material. The AASHO and Unified Classification, and the shrink-swell potential give an indication of the traffic supporting capacity. Thickness of the borrow material, wetness, and stones or rocks influence the ease of excavation as . borrow material.

Properties Affecting Use	Suitability of Soil Good	Fair	Poor
Unified Classification 1/	GW, SW, GP, GM SP, GC, SM	SC, ML, CL	OL, MH, CH, OH, Pt 3/
AASHO Group Index	O-4	4-a	More than 8
Shrink-swell potential	Very low, low	Moderate	High, very high
COLE	Less than .035	.035 - .06	More than .06
PVC	Less than 2	2-4	More than 4
Wetness 2/	Excessive to well drained	Moderately well to somewhat poorly drained	Poorly and very poorly drained
Thickness of suitable material	More than 5 feet	2-5 feet	Less than 2 feet
Stoniness Class 2/ (percentage of loose stones over 10" diameter on surface)	0, 1, 2 [less than 3%)	3 (3 to 157.)	4, 5 (More than 15%)
Rockiness Class 2/ (Percentage of fixed rock, exposed at surface)	0, 1 (Less than 10%)	2 (10-25%)	3, 4, 5 (More than 25%)

1/ In areas subject to frost action, CL and the silt loam part of ML are rated severe, SM is rated moderate.

2/ Classes defined in Soil Survey Manual - USDA Handbook 18, 1951

3/ Very poor or unsuitable.

Discussion:

Clean sand or gravel may not be desirable because of danger of settling of the fill.

AVAILABLE WATERHOLDING CAPACITY RELATED TO SOIL TEXTURE

Texture	AWC in/in[1/]
clay	.14 - .16
silty clay	.15 - .17
sandy clay	.15 - .17
silty [illegible]	

Charge No. 2 - Outline For Guide Book To Engineering Interpretations Of Soils

The committee recommends the following title and outline for the guide book:

"Guide Book far Users of the Published Soil Survey"

I. Forward - (Tell who the guide is written for-people from other disciplines)

II. Soil Terminology and Soil Identification

A. Soil (Give the various definitions of soil with special emphasis on definitions used by the engineer and the soilscientist)

B. Soil color (Brief summary of Munsell system and significance of soil colors)

C. Soil Texture, coarse fragments, stoniness, and rockiness (Give texture classes, texture triangle, and reproduce tables 3, 4, and 5 on pp 214, 220, 222 of Soil survey Manual)

D. Soil Structure (Reproduce figure 44, page 227 and Table 6, page 228 of Soil Survey Manual and explain significance of Structure)

E. Soil Consistence (Briefly define dry, moist, and wet consistence classes)

F. Soil Reaction and effervescence (Give terms and ranges in pH)

G. Soil Horizons (Briefly define soil horizon designations as given in May 1962 Supplement to Agricultural Handbook No. 18, and include horizon designations for Histosols which was recently adopted)

H. Soil Profile (Give idealized profile as on page 1169 of "Soils and Hen" but need to update horizon designations)

I. How A Soil Survey is Made (Expend on the discussion used in all recent published soil surveys)

J. Availability of Soil Surveys (Refer to "List of Published Soil Surveys," U.S. Dept. of Agriculture, Soil Conservation Service, April 1969 and discuss soil surveys in progress)

III. Soil Formation end Classification

A. Factors of Soil Formation

1. Parent material
2. Relief
3. vegetation
4. Climate
5. Time

General discussion of factors as they relate to soil genesis

B. U.S. Department of Agriculture Classification System

1. Order
2. Suborder
3. Great Group
4. Subgroup
5. Family
6. Series
7. Phases (not presently a part of system)

Brief definitions

C. Engineering Classification Systems

1. AASHO
2. Unified

} Brief discussion, with reference to items 1 and 10 of Bibliography

IV. Glossary of Terminology

Aeolian
Aggregate, soil
Alluvium
Andesite
Aquifers
Argillite
Arkose
Ash, volcanic
Association, soil

Badlands
Basalt
Basic Rock
Bedrock
Bench
Bottom land
Bulk Density

Calcareous, soil
Caliche
Capability Classification land
Capilary, water
Cementation
Chalk
Chert
Claypan
Coastal Plain
Colloid, soil
Colluvium
Complex, soil
Concretions
Consolidated
Coulee

Diatomaceous Earth
Drainage, soil
Drainage Class, soil
Drift. Slacial
Dune

Eluviation
Erodibility
Escarpment

Floodplain
Fragipan

Genesis, soil
Glaciofluvial Deposits
Gneiss
Granite
Gravitational Water

Hardpan
Humus
Hydrolysis
Hygroscopic Water

Igneous Rock
Illite
Illuviation
Impervious
Inclusions
Indurated
Infiltration
Inherited Characteristics of soils

Kaolinite

Lacustrine
Leaching
Limestone
Loess

Made land
Marine Material
Marl
Microclimate
Microrelief
Mineral
Mineral, soils
Montmorillonite
Morphology. soil
Mottled
Muck

Organic matter
organic Soil
Ortstein
Outwash

Parent Material
Peat
Ped
Pedology
Perched Water Table
Percolation
Permeability
Porosity
Pumice

Volcanic

Quartz

Recent Soil
Regolith
Relief
Residual Material
Rhyolite
Runoff

Saline
Sandstone
Schist

Sedimentary Rock
Separate, soil
Series, soil
Sesquioxide
Shale
Shot
Site Condition
Slate
Slope, soil
Soil Condition
Soil Quality
Soil Property
Solum
Stratified
Subsoil
Substratum
Subsurface Soil
Surface Soil

Talus
Terrace
Texture
Till, glacial
Transported Soil Material
Truncated Soil Profile

Upland

Valley

Water Holding Capacity
Water Table
Weathering

Report of Committee 6 - Charge 2 (cont'd)

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Discussion:

It was very apparent from committee discussion and discussion of the conference that communication is 8 universal problem. The guide book will need to be written with all of the disciplines cooperating in order to bridge the communication gap.

One of the major stumbling blocks is that the soil scientist considers soil as the product of the five factors of formation and as such considers such things as slope. drainage, and water table as part of the soil. The engineer considers slope, drainage. and water table as site conditions and not as part of the soil. These differences in approach will need to be spelled out in detail in the guide book.

The committee recommends that moist consistence be determined at the moisture percentage of the plastic limit. This will make our moist consistence values more meaningful to the engineers using the soil survey information.

Committee 6 - Membership

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
"SST REGIONAL TECHNICAL WORK PLANNING CONFERENCE
for
SOIL SURVEY
Las Cruces, New Mexico, January 26-29, 1970

Report of Committee 7 - Soil Interpretations At The Higher Categories Of The New Soil Classification system

The committee was assigned the following charges: Suggest guidelines for forming taxonomic unit. that will support the most valid interpretations by:

1. Evaluating and refining the national committee's guidelines on map scale snd legend for smsll-scale ❑ .P. to obtain maximum interpretive value. These are:

   (a) County Maps. Use phase. of associations of soil series s. components in the legend .. with map scales ranging from 1:125,000 to 1:250,000 (two to four mile. per inch). I" s few instances larger scales may be needed.

   (b) State Maps. Use phases of associations of families of subgroup. . . components in the legend with map scale. ranging from 1:500,000 for small states to 1:1,000,000 for average-size states. I" some states phsse. of associations of subgroups may be the better categorical level to use.

   (c) Regional Maps. (Larger than one state). For small regions use the same legend and map scale ss for state. (b above) and for moderate and large region. use phases of associations of subgroup. s. component. in the legend st . p scale. of from 1:750,000 to 1:2,500,000. Phases of associations of great groups may also be used.

   (d) National Hap.. Use phases of associations of greet group. at s map scale of 1:1,500,000 to 1:7,500,000. Phases of associations of subgroup. may also be used.

2. Considering the feasibility of using phases of more ths" one categorical level in small-scale maps.

Before commenting on the charge. we should first like to discuss some items that wc feel are significant to small-scale maps and the use of such maps for interpretive purposes. We list them not because they are original but because s few of them may be overlooked and some have . bearing on our discussion of the charges.

Most msp unit on small-scale soil map. are . ssociations. The associations may be of order., suborder., great group., subgroups, families, or series, or of phase. of any of these [illegible]

fs..il280t

Phases can be as useful on small-scale maps as on detailed maps, and the same principles apply in “sing them. Any class of any category may be subdivided into phases based on any characteristic significant to “se or management. Phases may be based on selected criteria for classes at lover levels of the classification system; for example, texture or temperature phases can be used at the subgroup level, and lithic phases can be used at the

At the national level, . new small-scale map of the conterminous United States is being prepared at . scale of 1:1,000,000, in which phases of subgroups are components in the legend. The first two (of . total of 13) sheets, covering the northeastern states, are nearly complete. There are 150 to 200 map units on • single sheet, 38 by 48 inches.

The legend contains statements regarding suitability of the principal component soils of each map unit for tilled crops, pasture, tree fruits, and timber and pulpwood, and limitations for foundations, shallow excavations, and septic tank filter fields. Most entries consist of . single rating--slight. moderate, severe, good, fair, or poor.

The small-scale map of the conterminous United State and the map of Alaska offer evidence that components baaed on phases of subgroups are feasible at . scale of 1:1,000,000. At a scale of 1:500,000, then, components bared on phases of families of subgroups should be possible.

This does not imply that map units based on associations of great groups. suborders, or even orders, are not useful for some interpretations. While many interpretations that can be made at the order level can also be made from a climatic map, in some • *e*s at least, accidental characteristics accompanying differences in classes may lead to useful interpretations.' At the suborder level it is possible to make interpretations bared on wetness, flood hazard, rainfall distribution, vegetation, and in some cases subsoil texture, for example. These and additional interpretations based on temperature, salinity, and hard underlying horizons, among other things, can be made for great groups.

Item 2. The committee recommends that one categorical level be maintained, if possible, on all maps. A" extremely complicated pattern of soils in one part of an area may, however, require . shift to a higher level. A shift in categoric., level might also be necessary where a great deal of derailed mapping has bee" done in part of an area and no detailed mapping has been done in other parts.

Alternatively, in an area where more than one categoric.1 level seems necessary, . map could be made using a higher level than possible for part of the area and providing a supplemental map (or maps) for areas where greater detail can be show".

A footnote explaining a shift in categorical level should be placed on the map sheet; e.g.,

1. Generalized from detailed soil surveys

2. Generalized by interpretation

References

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Some Geographic Aspects of the Seventh Approximation, A.C. Orvedal, and Morris E. Austin, Soil Science Society Proceedings, March-April, 1963.

Notes, Western States Workshop on Small-Scale Sail Maps, September 6-8, 1967.

Committee Members:

R.P. Mitchel, Chairman	J. Hagihara	S. Rieger
H.A. Fosberg	E.M. Richlen	W. A. Starr

Committee 7 - Soil Interpretations At The Higher Categories Of The New Soil Classification System

Discussion

Considerable discussion took place during ."d after presentation of the committee report. Among the comments made were the following:

Flach: People will "at make the effort to determine components within . map unit on a small-scale map.

Rieger; Describing position of the components so they can be identified in the field is important in undeveloped areas where only small-scale maps are available. Describing position of components is less important where small-scale maps are compiled from detailed maps. Map users must study the text accompanying the map. Interpretations should not be more detailed than can be justified by the map scale.

Mogen: It is necessary to describe components in terms of position in the landscape.

Huff: I don't think wc want to encourage people to locate specific components, because mistakes are likely.

Wohletz; Small-scale soil maps are needed for general planning. Objectives are different from those of detailed maps.

Link: Different arrangement of components for separate interpretations may lead to confusion.

Mogen: It seems reasonable to compile just one map and help people make single-purpose interpretations from this map.

Arkley: Naps for single-purpose interpretations should not be based on small-scale map. Boundaries may be quite different for different interpretations. Each single-purpose map should be produced from slightly generalized detailed map at a reduced scale.

Huff: Cost of producing separate interpretive maps too great.

Peterson: I don't see how the usual small-scale map can be used for planning. Computer could produce small-scale map with same detail as large-scale map. Color pattern similar to general map would emerge as map is inspected visually.

Simonson: This is useful in interpretation of detailed survey.

Arkley: Reduction or generalization produces map that can be put on wall for easy inspection.

Huff: Not desirable for people to make detailed interpretations from generalized maps.

Wohletz: Host useful scale is 2 miles = 1 inch. Smeller scale maps "at too useful

? : Generalized maps are wanted by county planning commissions and others. Something is needed between detailed map and usual soil association map. Need a map with a simple pattern. Complex map is "at useful for general planning.

Chairman's comments: The discussion indicated that there is considerable disagreement on usefulness of small-scale maps and the kinds of small-scale maps that are needed.

The conference members accepted the committee report and recommended that the committee be continued.

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY
Las Cruces, New Mexico
January 26-29, 1970

Report of Committee 8 -- Soil Survey Procedures

The charges given to this Committee are:

1. The feasibility of obtaining and using small scale satellite photographs (infrared and other) to supplement the black and white base map photographs in soil surveys.

2. Consider the desirability of correlating series interpretations as part of the national soil correlation procedure.

3. Attempt to collect information about existing techniques for improving field soil survey procedures - for example, the use of portable seismographs, improved augers, etc.

The charges given were considered by the Committee, and the following recommendations are submitted:

CHARGE 1

A. Recommends that high altitude photography be used to the maximum extent possible in all phases of the soil survey program. Efforts should continue in exploring means of expanding its use beyond what is now recognized as feasible.

High altitude photography has proven to be useful in areas where relief differences are not too great for compiling atlas sheets direct from original negative and for the development of ortho photo mosaics maps. Expanded use for field mapping also offers considerable potential for improving field procedures in matching, evaluating map detail, and preparing field mapping for publication.

B. Recommends that an organized program be developed to expand and accelerate as much as possible the testing and evaluation of the potential uses for color photography in the soil survey program. The program should encompass all phases and techniques of color photography as well as high and low altitude coverage.

The Committee fully recognizes that the application of color photography to soil and land investigation is relatively new and is more costly than black and white. However, it is believed that for some specialized uses, its potential for improving soil survey procedures is sufficiently great to warrant the additional cost. At present this potential appears to be most promising when used to supplement landscape evaluation for black and white field sheets. Some color photography shows considerably more detail than possible with black and white photos. To reduce overall cost, it would appear that mapping could continue to be done on black and white photos: but, where suitable color photography is available, it be used to supplement the black and white photos.

It is also recognized that color photo coverage is limited and that not all color photography is suitable for application in soil survey work. To the extent possible, an inventory of available color photography should be compiled and supplied to appropriate offices. The inventory should include all sources willing to cooperate in such a program. To adequately test and evaluate the use of color photography in soil survey field procedures, training of selected and appropriate people would be necessary.

Satellite photography appears to offer only limited value in the sail survey program. The extremely small scale presents problems for detailed interpretations. It may have some potential for broad interpretations or landscape evaluation. Additional testing is needed to adequately evaluate the use of satellite photography in the soil survey program.

Comments: John A. Williams of the Forest Service reported that sore use of color photography is being used by the Forest Service. He estimates that the use of this color photography in their resource inventory procedures can save them an average of 50 percent in field time and work.

It was also painted out that there is planned en Earth Remote Observation Sensing Program that offers considerable potential for use in the soil survey program. It was suggested that this program be monitored to determine the value this program can have to various aspects of soil survey and soil interpretations.

Richard C. Huff, State Soil Scientist, Soil Conservation Service, California, submitted to the Committee preliminary reports of the use of color and color infrared photography in the State of California. A brief summary of these is included here. More detailed information can be obtained from Richard Huff.

Placer, California, Soil Survey Area. Area studied comprised about 345 square miles. Color and color infrared, 35 mm film was used. About 85 square miles were photographed with only Kodak Ektachrome MS with UV filter and the remainder was photographed with additional simultaneous exposures of Kodak Ektachrome Infrared Aero Type 8443 with Wrattan No. 12 filter. About half the area was flown at altitudes of 5,000 feet and the remainder et 7,500 feet. Flight data was Hay 5, 1969. The California State Department of Water Resources contracted to do the photography.

Cost of the photography, excluding about $22 of Ektachrome Aero Infrared film that was donated by Kodak to California State Department of Water Resources, was about $306 or about 88 cents per square mile.

The report states that color and color infrared photos gave some soil interpretation information that was not discernable on black and white field sheets. This included better information on distribution patterns and extent of certain soils, "The color infrared photography vividly depicts the extent of the soils on which the vegetation was in varying stages of moisture stress conditions and it was noted that this can be related to certain soil series." Benefits other than those related directly to sail interpretations were also reported. These include helping in orientation in the field, updating changes in cultural features, land use and reference for evaluating made and shaped soil areas.

At the time the preliminary report was made (August 21, 1969) full evaluation of the study was not completed and additional benefits were expected.

Modoc, California, Soil Survey Area. Area comprised about 320 square miles. Film used was Kodak Ektachrome Aero, Type 8442, E-3 process. Filter used was KLF-36 plus HF-5. Negative size was 9 x 9 inch contact positive transparencies with a scale of 1:36,000. Altitude was 22,800 feet. Flight date and time was August 3, 1969, between 1045 and 1221 POT.

The cost of this photography for the area covered was $598.25 or $1.87 per square mile. This cost was lower than usual due to unusual provisions of the contract that probably will not be available in the future.

Full evaluation of this photography has not been completed but the preliminary report (September 5, 1969) states that the use of color photography in this situation "has revealed easily recognizable soil color patterns and because of the scale and area covered, the distribution and extent of these soils can be accurately projected and evaluated." This report also indicates that this color photography aided in setting up rapping units, delineating contrasting soil bodies, determining the extent and composition of inclusions and complexes and to accurately characterize these delineations in a way not possible or practical with panchromatic field sheets.

CHARGE 2

A. Recommends that the Western States adopt fhe systematic use of soil survey interpretation sheets for soil series and that rating criteria be developed and coordinated between the Western States and other states where necessary; and if the use of soil survey interpretation sheets is adopted, the Committee further:

B. Recommends that the Regional Technical Service Center give leadership in coordinating soil survey interpretations for soil series.

C. Recommends that the states be responsible for technical adequacy of soil survey interpretations for phases of soil series.

D. Recommends that an active committee of appropriate people in the Western States be appointed by the Principal Soil Correlator to develop rating criteria and soil survey interpretation sheet(s); that the committee include specialists in appropriate related fields of interest as well as soil scientists.

E. Recommends that soil survey interpretation sheets be developed as completely as existing data permits for all newly proposed and revised soil series and that these interpretation sheets be circulated for review at the same time the review drafts of the soil series are circulated. Interpretation sheets for existing adequate soil series descriptions be developed and coordinated as rapidly as possible.

The Committee was unanimous in recognizing the need for the systematic development and review of soil interpretations. The Committee was also in full agreement that the soil series and phases of soil series are the logical level for coordination. However, the sail survey interpretation sheet must be separate and distinct from soil series descriptions

The Committee believes that emphasis should continue in developing all phases of presently recognized soil survey techniques and procedures and promoting their maximum use wherever possible. These include:

a. Develop and use all available background information prior to actual mapping or as early in the survey as possible. This should include such material as geology, geomorphology, ecology, climatic, U.S.G.S. topographical maps and all available aerial photography (older as well as recent high and low altitude, mosaics, etc.).

b. Full use of stereoscopic analysis before, during and after field examination.

c. Greater use of high altitude maps or sections of mosaics in place of or to supplement large scale small size field sheets that prevent analysis and understanding of landscape and soil relationships.

d. Encourage and present challenges to field soil scientists to develop their natural inquisitiveness and investigate all phases of soils during field work. Reduce as much as possible routine, automatic mapping.

e. Present opportunities and encourage field soil scientists to participate as much as possible in decisions about soil classification, interpretations, and correlations.

The work of Committee 8 and the discussions on the report indicate there remains much work to be done related to the use of various kinds of photography and remote sensing in the soil survey program. It is recommended that the Committee be continued.

The recommendations of Committee 8 were accepted by the conference.

Committee Members:

V. G. Link, Chairman
D. F. Bauer
J. F. Corliss
M. A. Fosberg
W. W. Hill
H. A. Homan
L. N. Langan
J. D. Nichols
W. A. Starr

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Las Cruces, New Mexico
January 26-30, 1970

Report of Committee No. 9 - Soil Family Criteria

This is a new committee to the Western Region so there is no report from the 1968 conference. The committee did review the 1969 report of the National Conference.

Charge 1: Consider refining the 1968 supplement to the New Classification treatment of very fine sand to assure realistic family groups.

Discussion: The March 1967 supplement and subsequent amendments made the following changes on page 38 of the New Classification:

1. Texture

5 - Sandy.1/ Sands and loamy sands exclusive of loamy very fine and very fine sand and 35% by volume or less coarser than 2 mm.

Footnote: 1/ Very fine sand (0.05-0.01 mm) is treated as sand it particle size class otherwise is sand, and as silt if particle size class otherwise is loamy.

An Intersociety Committee far Standardization of Particle-Size Ranges, under the leadership of SSSA, has been studying the problem since 1966. The

.06 - .10
.10 - .25

It was the consensus of the committee members replying to the charge that a realistic grouping would be made by adopting the break at .074 (ZOO sieve) used by the AASHO and Unified classifications. One committee member suggested a sliding scale in which the greater the amount of clay the greater the necessary percentage of silt in the silt plus very fine sand.

Recommendation: The conference accept the recommendation of the position paper by the SSSA that the upper limit for silt be shifted from 0.05 mm to 0.06 mm. Treat all coarser particles as sand and drop the footnote regarding the treatment of "cry fine sand in the New Classification. This change will also bring the Soil Survey Laboratory data into closer agreement with AASHO. As noted in the ASCE position paper, "It is quite possible that the difference between percent finer than 0.074 mm

Charge 2:

Charge 3:

Charge 4:

IT IS RECOMMENDED that this committee be continued. Soil families containing large numbers of series should be reviewed and firm recommendations

families. This committee work start soon as the is

COMMITTEE MEMBERS:

R. F. Bauer	D. S. Romine
	C. Singleton
Huff, Chairman	E. L. Spencer
J.D.	L. Wilson
Rieger	

The Conference voted to accept the report of Committee No. 9 and for continuation of the Committee.

to more

REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
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January 26-30, 1970

Report of Committee 10: Handling Soil Survey Data

1. Charge to committee: To consider and evaluate procedures now being used as well as possible new procedures for handling soil survey data, including field and interpretive as well as laboratory data.

2. Background: Work in using ADP for soils has started roughly simultaneously in several experiment stations. Among others, Arkley at Berkeley and Swindale in Hawaii in the West, as well as Rusk at Minnesota and Bidwell at Kansas have been using computers for analyzing morphological and other soil data. In part at the urging of these gentlemen, the Soil Survey started efforts toward a uniform code for recording soils data in late 1967. These efforts have been under the leadership of Cliff Orvedal and Dwight Swanson in Washington. A workshop on ADP in Soil Survey was held in August 1968 and the 1969 National Work Planning Conference in Charleston bad a committee on ADP. Cliff Orvedal, with the assistance of Dwight Swanson, was chairman of the workshop and the committee. Several data files are envisaged; these files and their present state of development are as follows:

a. Pedon data (PD) Pile. This is a comprehensive coding system for morphology and laboratory data developed by Swanson. It was discussed during a workshop in Washington in August 1968, and some 16 copies of this rather voluminous document have been sent out to people who were thought to be Interested in it. Several people have made further suggestions to improve the coding system end another round of discussion seems necessary before the system can be finally adopted. Several reactions to tbe system will be given later in this report. Due to pressure of other work no great amount of work has been done on the system during 1969.

b. Soil classification (SC) Pile. This file was created during 1969 and all presently recognized soil series have bee" incorporated in it. The information contained in this file consists of the series name, the state responsible for the series and the subgroup and family class in the new system. The classification file consists Of the following subfiles:

1) PL file. A listing of all series prepared by the four Principal Correlators.

2) SR file. A listing of all series prepared by the Director of Correlation.

3) ED subfile. Containing all subgroups and all components of family names of the classification system as well as state name abbreviations.

Cards for all series have been punched and programs for the following functions have been written and executed:

1) List series alphabetically.

2) List series by families.

3) Compare PL and SR files and report discrepancies.

4) Compare PL or SR file with the ED file and report discrepancies.

c. Series descriptions (SD) Pile. No progress has been made so far. In format this file will in part resemble the PD Pile.

d. Soils interpretation (SI) Pile. The objectives of this Pile are as follows:

1) Print principal interpretations by geographical areas.

2) Print principal interpretations of principal phases of taxonomic units.

3) print restrictive soil characteristics for a given interpretation.

4) Print list of soils with specific interpretive ratings.

Work on this file is in initial planning stages.

e. Cartographic soils data (CSD) file. This file is to contain information about the geographic distribution of soils. No work on this file has been done as yet. Digitizing equipment that defines cartographic parameters in terms of X, Y, and Z parameters has been purchased, however, end is being used by the cartographic units of the Soil Conservation Service and by the Forest Service. Detailed description of this equipment is Contained in a report by Mr. Homan to this conference.

3. Activities of this committee.

a. survey of ADP activities in Soil survey in the Western States. The committee sent questionnaires to the cooperative land grant colleges and the Forest Service seeking information on ADP activities at the various institutions.

b. We received replies from ten states and the U. 6. Forest Service. Results may be summarized as follows:

1) Significant activities in ADP for Soil survey are going on at the following institutions: University Of California, Davis; university Of California, Berkeley; University of Hawaii; Montana State University; University of Idaho; Washington, State Department of Natural Resources; U. S. Forest Service at Berkeley; Western Regional Technical Service Center, Portland; Soil Survey Laboratory, Riverside; and the Cartographic Unit, Portland. Other respondents expressed strong interest but had little to report.

2) The computer hardware available apparently is very good but is of great variety including the following: IBM 360, 1130, 6400, 7060; Philco 2000; Sigma 5 and 7; CDC 1700, 3500, 6400; Burroughs 6500; Univac 1108, 9200. It may be assumed that similar equipment is available at the institutions that did not reply.

3) A few programs for handling soil survey data are available as well as programs that may be adapted. Tapes containing climatic records for the respective states are available at several institutions.

4) The following is a summary of the reports Prom institutions with major ADP activities:

a) University of California at Davis. Mr. Allardice has been using a program for processing laboratory data since 1967. The program reads instrument measurements on mark sensing cards end prints out standard data sheets.

b) University of California, Berkeley. Dr. Arkley has used computers for factor analysis and cluster analysis of soil properties, and for numerical taxonomy using methods adapted from programs developed by psychologists. He has a system for coding morphological data and has analyzed six sets of date from California, Ohio, and the 7th Approximation. He has programs on factor analysis and cluster analysis of soil properties and numerical taxonomy and several tapes of statistical programs including multiple regression, analysis of variance, and cross-tabulation.

c) University of Hawaii. Descriptions and data on all Hawaiian soils for which data are available have been coded and punched. The coding system is similar to the PD file but it has been modified to take care of conditions peculiar to Hawaii in terms of soils and vegetation. So far 50 of the 198 series in Hawaii have been incorporated in the system. The system has been used to predict parameters for soils for which data were not available and for listing and ranking soils having certain properties. It has also been used to allocate clay mineral from chemical and differential thermal date.

d) Montana State University. All pedon data (descriptions and data) in the SSIR volume on Montana (SSIR No. 7) have been coded and punched and other data are being recorded,, using essentially the PD coding system. Montana is planning to write programs in Fortran IV to utilize these data.

e) university of Idaho. Io cooperation with the Range Science Department and OSU a coding system for vegetation and soils morphological, chemical, and physical data has been developed. Range vegetation data from a 12-year range vegetation - soils ecology study have been put on tapes and soils data have Men coded.

f) Mr. Brackett of the State Department of Natural Resources of the state of Washington, in cooperation with Washington State University end SCS, developed the "Soils Oriented Information Listing System" (S.O.I.L.S.). The system consists of a state soil series file, a soil data storage file, a soil data index file, an irrigated land capability file, and a type description file. Each of these files consists of the following:

1) state soil series file

Soil series name
Map code
Stature (tentative or established)
Subgroup and family classification
county Of type location

2) Soil data storage file

Type of analysis (methods) card
Color card
Description cards
Physical analysis card
Chemical analysis cards
Mineralogical analysis cards

3) Soil data index

This index is created from the soil data storage file by the soil data editing procedure.

4) Irrigated land capability file

Soil series name card
Characteristic and quality card
Capability and crop adaptation cards
Location card

5) Type description file

This file consists of uncoded, narrative official series descriptions.

The system contains codes for morphological descriptions in the soil data file and codes for methods, irrigation capability, and capability units. Programs have been developed for entering the data in the file, editing the data, and for update procedures. The state soil series file has bee" completed and apparently considerable progress has been made on the other files.

g) Forest Service. The state Cooperative Soil-Vegetation Survey[1/] has coded the following:

1. Soil-Vegetation plot records including profile descriptions.

2. Laboratory data (see item a).

[1/] C. W. Colwell, ADP, Progress by the State Cooperative Soil-Vegetation Survey, presented at the Western Regional Technical Work Planning Conference, Riverside, 1968.

3. vegetation computer program. codes for wildland, plots, and for grassland, wildlife, and limited aspects of the Soil-Vegetation survey.

4. Soil series classification. Selected properties for approximately 350 upland soil series.

h) Soil Correlation. The Western Regional Technical Service Center has punched cards for the PL file of the Western States. All series have bee" punched and print outs have bee" prepared.

i) Soil Survey Laboratory, Riverside. Since January 1969 all handling of laboratory data is being done by computer. Instrument readings are recorded and the data are put in disk storage from which conventional data sheets have bee" prepared. The data CM be used for the PD file.

j) Cartographic Unit, Portland. Equipment for digitizing cartographic information, a "Coordinatograph", has been installed. This equipment enters X and Y coordinates of soil lines and symbols on tape, gives areas of soil areas, and allows retrieval of the data for a national databank. From the magnetic tape, an automatic plotting machine can prepare final scribed soil maps.

c. Comments on pedon data (PD) file: Several comments on the PD file concerning coding operations and the organization of the file were received.

1. Entering data in the file. As mentioned before, Montana State University baa coded and punched some 160 pedons from SSIR No. 7. They found coding and punching using the examples given in the PD code manual impractical. Consequently, they reorganized the coding process so that five cards were used for general information on the pedons and 15 cards for each horizon using a standard format. While this uses a lot of cards (that are cheap) they can code one or a few features at a time which eliminates a great deal of looking up codes in the handbook. They the" rearranged the cards mechanically so that all the cards of a pedon were in the proper sequence. Dr. Nielsen estimated that doing it this way a coder can code about one pedon per hour and that a card punch operator would need about one-half to one hour to punch one pedo". Hence, it is likely that punching descriptions and data is no more expensive than typing. A copy of Dr. Nielsen's coding sheet is available to the conference. As things were done at Montana, a relatively large part of the coding effort dealt with the pedon descriptions, and a relatively large part of the card punching effort with the laboratory data. Since laboratory data will be available on tape, the punching costs will probably be reduced if a form that is designed with the coding requirements in mind is used in the preparation of the original pedon descriptions.

2. Several soil scientists who had studied the proposed PD code felt that it was too long and complex in trying to be comprehensive. The Montana experiment shows that the actual coding is largely determined by the complexity of the description. We estimate that one coded pedon requires about one foot of tape. A standard computer tape is 2500 feet long. While the bulk of the PD record on tape does not seem to present problems, handling the extensive records in the working memory of the computer may. This problem may be minimized by organizing the morphological and the laboratory data into blocks and entering into the working memory of the computer only those that are needed for a specific purpose.

3. Hawaii felt that it needed space on the record for conditions peculiar to Hawaii.

d. Further consideration for the PD record:

1) The coding system should be finalized as soon as possible. To do this we need some clear statements of the objectives of the pedon data record. Some people, for example, have tested the coding system to see whether it is possible to create computer programs that would classify the pedon in the new classification system. They found that several refinements were needed both in the coding system and in "Manual" definitions to get sufficiently unambiguous statements.

Others have held that this was not a major objective of the PD record. We also need to clarify the relationship Of "Manual" definitions, such as horizon designations, to the criteria in the classification system. Horizon designations, for example, would be convenient labels in searching the PD record for diagnostic horizons, if they were fully correlated with diagnostic horizons.

2) Coding sheets similar to the ones used in Montana should be prepared.

3) Basic programs for converting coded punched cards to the format used on the tape and programs for printing out We information on tape should be created as soon as possible.

Recommendations:

1. Cooperative efforts should be made to accelerate the adoption of ADP methods in Soil survey.

2. The pedon data record coding system seems to be largely satisfactory. It should be finalized as soon as possible without major modifications from the present proposal.

3. Coding Instructions and coding sheets should be prepared.

4. Cooperative agencies and SCS should be encouraged to prepare comprehensive programs "sing the format of the PD record.

5. I" view of the diversity of equipment that is used by the cooperating agencies, programs should be in computer language that can be used by a wide variety of equipment (Fortran IV and Cobol).

6. A national clearing house should be established that maintains tapes of Soil Survey data, programs for Soil Survey and in general collects and distributes information on the "se of automatic data processing in Soil Survey.

7. This committee should be continued and serve as a regional information center in automatic data processing. Individuals interested in automatic data processing should be invited to join the committee.

The report and recommendations were accepted by the Conference.

Committee Members

K. W. Flach, Chairman
K. E. Bradshaw
W. L. Colwell
D. M. Hendricks
H. A. Homan
E. A. Naphan
C. A. Nielsen
Goro Uehara

NATIONAL COOPERATIVE SOIL SURVEY

Western Regional Conference Proceedings

Seattle, Washington
January 28-31, **1964**

Roster of Attendance,

Name	Agency
Merle R. Britton	scs
Charles E, Kellogg	USDA SCS
R. A. Gilkeson	Wash. State Univ.
R. W. Eikleberry	scs
L. R. Wohletz	scs
Adrian D. Nelson	VSBR
Charles A. Rowles	Vniv. of B. C.
Ellis G. Knox	Oregon State Univ.
R. F. Tegner	SCS
Merlin Smith	Dept. Natural Resources
Arthur G. Sherrell	U.S. Forest Service
James U. Anderson	New Mexico State Univ.
Harrison J. Maker	scs
Maynard A. Fosberg	Univ. of Idaho
Joe W. Kingsbury	SCS
Rodney J. Arkley	Univ. of California
Dave R. Cawlfield	SCS
Fred E. Gehrke	Weyerhaeuser Co.
William M. Johnson	scs
Ronald C. McConnell	
E. C. Steinbrenner	
G. Donald Sherman	
William W. Hill	
E. A. Naphan	
M. D. Magnuson	
E. Hilton Payne	
Dale S. Romine	
Stanley W. Buol	
G. H. Simonson	
Alvin R. Southard	
Lemoyne Wilson	
Oscar P. Mueller	
C. T. Youngberg	
Fred E. Schlota	
Earl L. Phillips	
Jack R. Fisher	
Jack Williams	
Milo S. James	
Daniel Y. Iritani	
Theron B. Hutchings	
Robert F. Mitchel	
L. E. Dunn	
Ray W. Chapin	
M. T. Buchanan	
Warren A. Starr	
P, Gessel	

SCS

Welcome
by
M.T. Buchanan, Director
Washington Agricultural Experiment Station

Good morning, and welcome to the Western Regional Soil Survey Work Planning Conference. I am told that this is a biennial regional technical conference of soil survey people--chiefly experiment station representativea, state soil scientists, and the correlation staff of the Soil Conservation Service. Representatives from some other agencies in survey work and technical specialists have been invited. In recent years, the Forest Service has been wall represented, This is quite appropriate and gratifying.

I understand that thin conference has rotated around the states. We are glad you chose Seattle this year. In addition to the expectation of good transportation schedules in mid-winter, the urban-industrial atmosphere is appropriate to your current considerations. I don't mean smog--I'm referring to figurative atmosphere of the urban-industry expansion problem. I note that at least two committees will consider aspects of that problem.

The fact that so many differ&agencies meet here is indicative of the cooperative program. Our own Washington Agricultural Experiment Stations has been an active partner with the USDA in soil survey work, since 1930. We began with the Bureau of Plant Industry, and continued with the Soil Conservation Service. More recently, the U. S. Forest Service, the Bureau of Indian Affairs, the Soil Conservation Districts, and Weyerhaeuser Timber Company have become involved. We have also worked with the Bureau of Reclamation in a related effort.

In addition to participating in the survey activity, we have done considerable research, WSU now has adequate research facilities and pereonnel actively engaged in work with differentiation and characterization of soils, and in areas of geomorphology, soil physios, chemistry, and mineralogy.

Most of the West is mountainous, and in the past had limited access for soil survey.. In recent years, forest management programs, development of water eupplies, and the increasing importance of recreation and wildlife management have encouraged survey work in many areas previsouly passed by in survey work. More lend has been covered by aerial photography on both a large and small scale. Wore people are doing inventory work, We are beginning to get our first real appraisal of natural resource6 in some of our remote areas.

It is encouraging to see soil survey activity in the mountainour areas of our state. Forest products are still our number one industry. Further, these upland areas are the backbone of our water supply. Proper management of the water and timber resources will require good soil inventories for planning and developmen

The need for interpretation of soils is expanding tremendously. We continue to be interested in soil and crop management as before, of course. But we now have a greater need than before for interpretations that relate to use of the land for recreation, as watersheds, and for good forestry and range practice and wildlife management.

Interpretation8 made from qualitative and quantitative differentiation among soils are important in decisions about alternative use, multiple use management, and in determining the most beneficial uses that can be made. The present project, the map and report6 of eoil distribution in the weet, will be a valuable reference.

Those making decisions about regional development and regional research should find the map particularly useful. We in Washington hope to continua this work with the development of a map and report of soil distribution throughout our state.

Our host city is a reminder of the land use changes caused by mushrooming cities and industrial expansion. Your committee on made or shaped soils will find such areas here, Your committee on soil surveys in urban and fringe areas, design and interpretation also will find this a stimulating environment,

A regional planning project wae completed in the Puget Sound areas, recently, You will probably hear more about this subject during your conference, Such planning projects deal with a complex use problem, but very much need the information your program supplies. We are told that it won't be long before the whole area from the Coast to the Cascades and from Portland to the Canadian border will be heavily populated. Rapid and significant changes are occurring in farming and in the handling of farm products here as elsewhere,

The regional planners have been and should continue more intensively to use information about soils. You can be helpful to such projects by sharing your ideas in conferences such as this. You also help by keeping abrest of the social changes that increase the use demand upon the land and require that priority decisions be made in the public interest.

By the tone of your conference, by the participation of the several organizations and agencies represented here, and by the committees you have working, you apparently are keeping in position to be very helpful in this changing land use situation in the high tradition of your prior service.

Best wishes for a successful meeting in Seattle, Washington.

Remarks Prom Area Conservationist

Merle Britton

Soil Conservation Service

Seattle, Washington

It is a pleasure to welcome you to Seattle as participants of the Western Regional Soil Survey Conference. Orlo Krauter, State Conservationist of the Soil Conservation Service, requestod I represent him, as he will be participating in the final review of an Internal Audit;

I will attempt to give you a quick rundown of soil survey work in this area of Washington and also a brief description of our Service Activities.

Cut work area covers the northwest portion of the State, extending from the Canadian line on the north, about 150 miles south to Mount Rainier National Park, and from the crest of the Cascade Mountains on the east to the Pacific Ocean; There are soil conservation districts in all ten (10) counties.

Dairying, grassland agriculture, woodland. and speciality crops such as vege-tables for freeeing plants, berries (strawberry, blue berries, and cane berries), flower bulbs, rhubarb, seed potatoes;

Our active soil survey work consists of a standard survey In Jefferson County; The other counties have published surveys dating from the late 1930's to the San Juan County Survey published last year; Many of the earlier surveys compare with our low intensity survey of today;

The Puget Trough area has a wide variety of soils, They range from the organic peats and muck soils to mineral soils with compacted subsoils, sands, gravels and unstable clays to the Alluvial in the many valley and tidal areas,

Drainage, streambank erosion are principal conservation problems along with periodic flooding of the streams and rivers.

Many new or additional demands are being made for information from our soils maps.

Fifty percent (50%) of the population of the State of Washington is centered around Seattle in four (4) counties - King, Pierce, Snohomish and Kitsap. The other 50% is scattered in the remaining 35 counties. This population expansion or explosion is making increasing demands on our soil resources. Much of the growth is occurring In the suburbs; This is creating a demand for soils information relating to:

1. Drainage fields for septic tanks

2. Are the soils on slopes stable enough for home sites, to take advantage of "view lots"

3. Information on soil that has high bearing strength for foundations.

4. County Assessors in two counties are using the published survey for assessment purposes, but have indicated need for more detail than in the published 1939 survey.

5. Planning Commission of King County and the Puget Sound Governmental Conference for use in preparation planning for a 4-county transit needs survey;

6. Planning for open area8 in relation to recreation;

A changing agrioulture and the rapidly changing pattern of population from rural to urban are creating needs for more soils

Bienniel Report

of the

Chairman, Soil Survey Work Group

to the

Wentern Regional Soil Survev Technical Work Planning Conference

Seattle, Washington
January 28, 1964

This report, for better clarity is presented in a chronological fashion, and, for better understanding, includes some past history of the Work Group pertaining to the Regional Soil Association Map Project.

During the period 1955-1959, the work group with state soil scientists, and regional correlation staff members of the Soil Conservation Service, held discussions relative to the development of a western regional soil association map; At the Regional Technical Work Planning Conference in Salt Lake City, Utah in 1958, a discussion of the regional soil association map was held. It was decided to prepare the map and legend, and to consider an amplified descriptive legend to be printed on the back of the map. In 1959, these same people, developed soil association maps for the individual, eleven western states;

At Las Vegas, Nevada in January 1960, in a work session preceding the regional technical conference, a regional soil association map was assembled from the individual state maps, and a suitable legend for the map was organized; It was decided to write a narrative report to accompany the map; During 1960 and 1961, this composite regional map was reviewed locally and by small intrastate groups to reconcile map boundaries and discrepancies involved with the use of the regional legend between states; At Las Cruces, New Mexico in 1962, in a work session preceding the regional technical planning conference, the soil survey work group members and personnel of the Soil Conservation Service, reviewed a composite draft of the regional soil association map, and the legend that was to accompany the map; In addition, three committees were established for the work session. The first committee drafted the original definitions for the great soil groups and miscellaneous land types to be used on the map and in the legend. The second committee wrote descriptive information about the individual map units. The third committee worked with an introductory statement of the physiography of the eleven western states.

During 1962, the drafts of materials for a manuscript to accompany the regional soils map were circulated for review and comments. After this review, it seemed to the majority of the group concerned with the map project, that a manuscript discussion of "Soils of the Western United States" was a useful and necessary companion to the soil map; It also appeared necessary that a different outline of presentation of material in the manuscript was needed, By correspondence, the following manuscript outline was agreed upon:

I Introduction
- a. Introduction
- b. Physiography
- c. Relationshipa, soils, physiography and vegetation

II Occurrence end Distribution of Soils

Group A. Light colored soils of the arid regions
1. Morphology and distribution of great soil groups
2. Composition of soil associations (charts)

Similar listing for all soil group.9

III Appendix

1; Descriptions for great soil groups within the vestern region.
2; Acreage distribution of soil association units summarized by states in the western region,
3; Glossary of common and scientific plant names;

In October

1. Do you want to delay this publication for a review of the finished manuscript, by everyone concerned, by correspondence?

2. Do you wish the manuscript to be exhaustive to the point of citation of all published material about the soils in the western region?

3. Do you want a uniform style and format, or allow the expression of style or individual authors? Do you want individual author credit?

4. Are you all willing to serve as editors and revies manuscripts in February? Only in February?

5. What do you wish to do about issue of the publication? Do you wish government agencies in all states to purchase their copiee, and other copies be issued free? Or do you wish each state to solve their own distribution? Remember there is a disparity between orders from individual states of frommm400 to 1,500 copies; This will cause difficulty and unfair cost between states, where copiee are issued free.

6. Do you all support the present format and style of the publication? If not, what do we add or delete?

7. Are there those who have suggestions, criticisms, or misunderstandings to be made or to have cleared up at this Conference, with reference to the soils publication?

Warren A, **Starr,** Chairman
Western Region Soil Survey Work Group

Remarks to the Conference

by Dr; C. E. Kellogg

The last two years progress in soil survey are encouraging from the standpoint of their affect and their quality; This progress has involved training of Area Conservationists as well as 8021 Scientists. There was more training of Soil Scientists, through conventional in-service training schools, and, in addition, two formal training schools held at universities; In the past, two university training schools have been held at Oregon State University, and four at Cornell University. The fieldmen say these schools are useful. The main purpose has been to get scientific desclpline, and to have the opportunity to read scientific literature,

In 1964, we want to do better with soil survey publications, We would like to get forty surveys published. Now the soil scientists in the field are completing field work on soil surveys more rapidly than we can get the reports published, and more rapidly than we can get funds for publications. It is also obvious that more people are using soil surveys for more uses and purposes than ever before;

The purpose of the soil survey and report is to bridge the gaps of interpretation between soil science, soil technology and research. Also in the survey and reports we are building knowledge about how soils will behave. The soil survey bridges between knowledge of soils and uses for soils. To serve the expanding needs for, uses of, and interpretations made of the soil survey, we have had to have some changes in soil classification and interpretations about soils.

Dr. Baver once asked 'When are we going to simplify the classification and mapping of the soils of New England?" "Make the maps more simple?" Actually these question6 could mean "When are we going to cease finding out new things about Soils?" We will cease expanding our classification and interpretations about soils when we cease learning about soils, and when we cease to get new uses for interpretation8 about the soil survey. There is actually little chance for change in the progress we must make; The south is a good example, Early in the soil survey program there, a few soils were prized because of abundant nutrients. Now days, in the south, soils areviewed and degregated with many qualities of water intake, slope, erosion, etc., in mind for interpretation to use. Land uses and other uses for soils have changed, and good soils, once degraded by use, are being redeveloped, Soils now respond to changing combinations of practices. The engineers have demanded information which has expanded the area of interpretation about soils, The old type of soil surveys and reports have been found inadequate to carry the load of modern interpretation needs about soils,

The purpose of any classification system is to classify knowledge. Our old classification system for soils was iuadequate to properly classify our modern knowledge about soils. This same analogy is true in other sciences as well as our own; Ninety percent of all the scientists who ever lived are alive today. This means a great number of new ideas, and new research findings are continually before us. Research sponsorship at the federal level has changed, as our economy has developed, and as defense needs have increased. The Hatch Act funds for research in agriculture are now peanuts compared to the total federal money spent for research; One can cite the NASA organization, conducting research for defense. We have had enormous experimental growth.

Soil Science started in 1899, but 1900 to 1910 and 1910 to 1920 brought more changes and additions to knowledge with each decade. There have been developments in the sciences of Physics, Chemistry, Geology, these fields related to Soil Science; New techniques have been given us for examining, classifying and interpreting about soils. The general process of advancement of soil science has not been dramatic, although there has been recent drama develop in the problems of expansion of the urban fringe. However, proper interpretation about soils has usually been considered after the catastrophe has'happened. In Lake County, Chicago area, four blocks of houses erected upon good former cornland, have had failure in construction, of one type or another. We can recall several million dollars lost in failure of housing near Washington D.C. in recent years, from improper considerations of land conditions before development; These events have some drama.

It is known that, the USDA and State Experiment Stations have an image problem. In the past agriculture has become synonymous with farming in the public mind. Farm labor has decreased, and farm people have migrated to cities; In contrast, agricultural processing has two and one half times as many people working; as are working on farms. Rural and urban problems in research and interpretationto management are different than those in agriculture. There is the *main* problem of water intake versus water runoff in urban and residential areas. Since people think that appropriations for agriculture are all subsidence to farmers. When considering needs for research, the farmer and the farm housewife are no different than the eutomobile worker or his housewife; Increased efficiency in agricultural production has reduced the number of people needed on farms, and the land needed in some land uses; However, the need for agricultural assistance is increasing in urban areas, Yet in the Congreeaional hearings, we are asked, "Why do you need agricultural funds to help urban people?" How do we clarify these image problems? People in general, and often, the legislature do not see that agricultural clientelle is changing and enlarging.

The Washington office has had opportunity for briefing and training of personnel being sent on foreign assignments; We feel this is good policy, and that personnell should have all the knowledge and acquaintance of a country that is is possible to get before proceeding to a foreign station assignment. The Washington office has considerable information and experience about foreign countries as a result of the world soil map projeot, and the experiences of our pereonnel abroad;

We always have one or two problems on hand in my office, In my job, it seems that is all the contact I get with the field, contact which presents problems. People write me when they are in trouble; One current problem in classification in climate, Do we need climatic phases? We have had some discussions with the Bureau of Land Management. We are classifying and mapping soils from the mountains to the deserts, The occurrence of Litbosol, Alluvial and Regosol soils having weak morphology range over wide areas of temperature, precipitation and grazing condition, yet within these ranges there is no soil difference. They all look alike. Appraisals for different future use and management are difficult to make; Wow do we determine and classify differences to allow different use and management recommendations that are easily explained? We may get some hints from local weather stations, or by comparison to adjacent normal zonal soils. May we use special lines placed upon local field sheets, but which do not appear on the published map? We have been experimenting with BLM with some local systems in Nevada, New Mexico and Montana; As we qua interpretations on range and forest lands, we find some facts of importance are not reflected in the soil. Some soils have wider range of adaptability than the crops which we want to grow,

There is another problem of soil survey operations. It is difficult to quickly assemble a report and maps that are suitable for publication; In some cases, symbols or maps are not appropriately placed or are absent in the legend, and report. We have become careless about goals, We must take publication goals serously. If target dates have to be changed, let the Washington office know.

The baae map for a publication has to be started well in advance of a publication target data; Some such base maps, started according to prearranged target dates, have become obsolete for publication due to delay of publication sch- edualing, caused by lack of notice of change of rchedualing; The other choice is to start cartographic work after the correlatiw, maps and reports have been received; This procedure would delay publication one to one and one half years.

We must have initial field reviews earlier in the progress of the survey. This would help the sequence of keaping on schedule and will test the legend earlier in the survey,, A full liet of soils, not just those needing local field review should be considered at this time, or at least at the progress review, and most certainly before the time for final correlation.

State cooperation in the soil survey is going well. We are pleaeed with the past cooperation. The states could take more responsibility, although they may not be able to contribute more financial assistance. Work plans and laboratory plans need more financial assistance. Work plane and laboratory plans need more responsible review. There is excellent chance to get assistance in the Soil Survey from departments other than soils. We can afford to do more thinking about the teaching phaee in soils. Those students who will major in soil science need not necessarily be cast in our own image; Students in soil science can always benefit by more courses in attendant sciences. It is not necessary for the soil science major to map soils, but spend his time in getting more courses in geology, mathematics, geomorphology, chemistry and foreign languages;

Upon the publication of a soil survey, presentation and interpretation of the survey to the local public by the Extension Service would be helpful. The best execution and full use of the soil survey must rely upon the best teaching for training of soil scientists, research data for timely interpretations, and extension methods for the proper introduction to and use by the general public.

Remarks to Conference
by
Dr; C.A. Rowles

Gentlemen, I very much appreciate the opportunity to attend this conference. First, I should like to second the remarks made earlier by Dr. Kellogg pertaining to breifing and training of personnel who are to take technical and professional assignments in foreigh countries.

Recently, I returned from an assignment to Venezuela. Before my departure, I spent some time in Washington D.C., with Dr. Kellogg and his etaff, receiving briefing and information about South America. This briefing waa of considerable value to me; While I profited from my experience in Venezuela, the students and teaching staff at the University of British Columbia will in turn profit from my experiences, and the information I gathered while in South America.

The soil survey group of the Dominion of Canada will meet in Otowa next week. They will discuss some of the same problems which you are deliberating here at this conference; The emphasis this year will be placed on land capabilities. This consideration of land quality started several years ago with a committee on land use in the senate. The committee found conditions of contrasting surpluses and poverty in some districts; There ware evidences of poor land development, sub-division and land use practices. ThisTh u Td 43s

Report of Conference Proceedings
Western Regional Technical Soil Survey
Work Planning Conference
Seattle, Washington
January 20 to 31, 1964

The biennial Western Regional Technical Soil Survey Work Planning Conference was held at Seattle, Washington, during the period

Chairman of the County Extension Staff, Ring County, Washington, addressed the Conference about Puget City-2000, a report on a regional planning study made relative fo future urban, residential and industrial growth in the Puget Sound area of northwestern Washington.

Technical Committee meetings continued through the morning session on January 30. During the afternoon session, reports from technical committees 1, 2, 3 and 4 were presented to the Conference; Reports from committee numbers 5, 6, 7 and 8 were heard during the morning of January 31.

In the afternoon of January 31, the Conference reconvened for the bienniel business meeting of the Western Regional Technical Soil Survey Work Planning Conference. Dale S. Romine invited the Conference to Ft. Collins Colorado for the 1966 Conference. This invitation was accepted by the group, Thus, automatically by conference procedure, Dale Romine became Chairman of the 1964 Conference, with E.M. Payne, Conference secretary. The Steering Committee consists of William M. Johnson, Chairman, and R. W. Chapin, Dale Romine, and E. M. Payne as members. The time for the Conference will remain during the Lest week of January.

There was some futher discussion of the statement on Purpose, Policies, and Procedures, for clarifacation of official membership in the Conference. However, the statement was passed by the Conference, It was pointed out that there is opportunity on other different membership to be nominated for vote and change of Purpose, Policies, and Procudure statement at the next Conference. Any proposed new or alternate members should be contacted for their interest and desire to become members, before nomination is made.

Summary remarks to the Conference were given by Dr. C. E. Kellogg. The Conference was adjourned at 3:00 p.m., January 31, 1964.

Statements, addresses, or remarks to the Conference, and the reports of technical committees are appended in order of appearance to this report of minutes of the Conference.

Warren A. Starr
Warren A. Starr
Secretary to the Conference

MAPPING TECHNIQUES AND CRITERIA IN SOIL SURVEYS ON FOREST AND RANGELAND

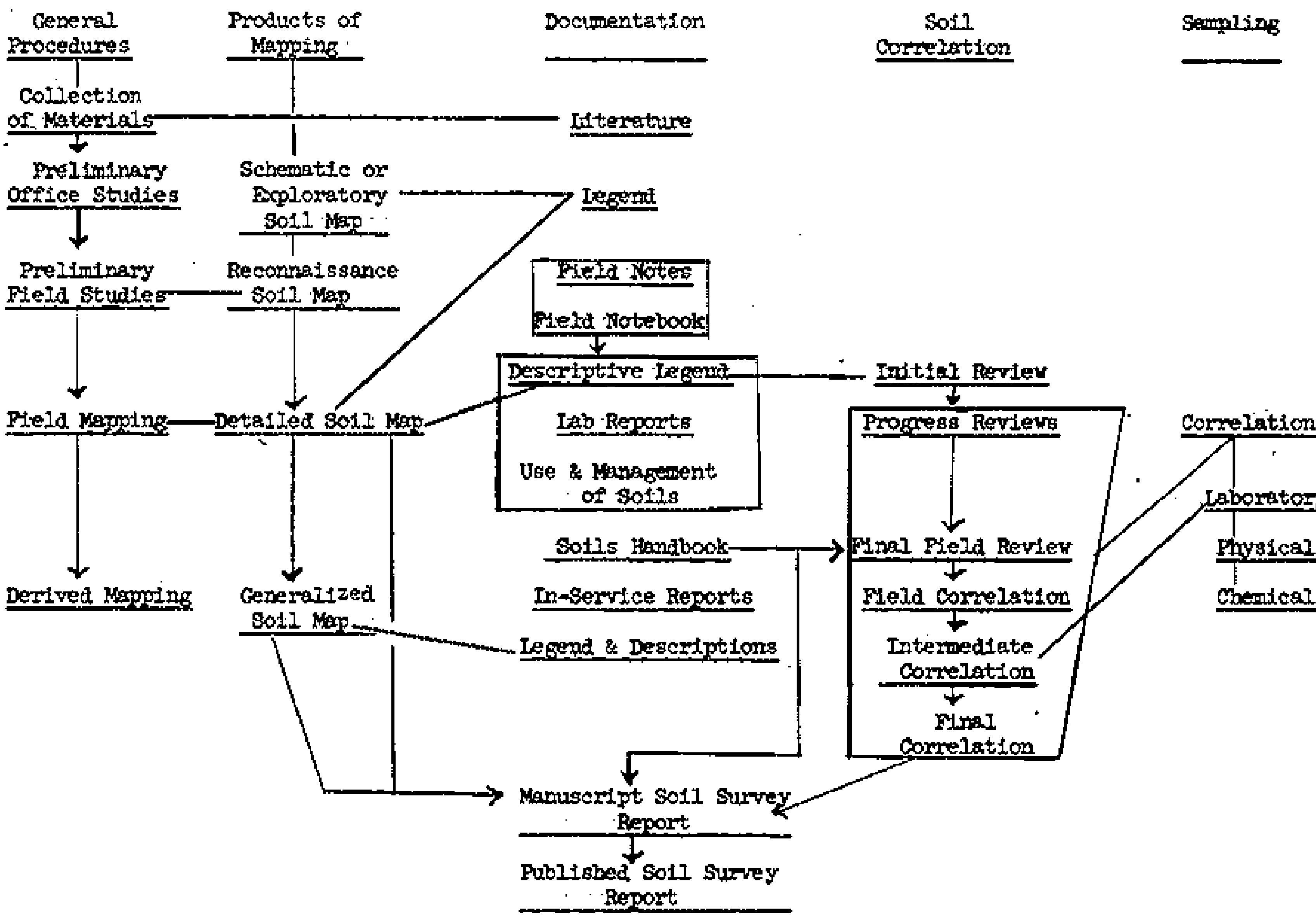
It is the purpose of this report to generally outline Soil survey procedures with special emphasis on those phases that are most important in mapping of forest and rangeland areas.

Guidelines for making soil surveys are found in the Soil Survey Manual (USDA Handbook No. 18, 1951). This material with other literature and experience of personnel in soil surveys and related fields was used. Many items are inserted mainly for information and education and to give the complete picture of soil survey procedures. The flow chart gives an outline of soil survey procedures. Major headings are:

1. General Procedures
2. Products of Mapping
3. Documentation
4. Soil Correlation
5. sampling

Arrows are used whenever possible to show direction of procedures and materials. Straight lines show a relationship between items of the chart.

SOIL SURVEY PROCEDURES FOR A DETAILED SOIL SURVEY



COLLECTION OF MATERIALS

Materials needed for the soil survey consist of literature, maps, and equipment. A list of some materials is as follows:

Literature

History with particular reference to use of the area and catastrophic events such as fire and storms

Published soil survey reports

Unpublished soil survey reports
- Soil handbooks
- In-Service reports

Soil series descriptions

Climatic data
- Weather Bureau reports
- Weather records, unpublished
  - In-Service reports
  - Multiple use plans
  - Station records

Geology
- USGS quads
- Books and other published material
  - USGS, State Departments, schools

Research
- Experiment Station publications, graduate theses, ARS publications

Vegetation
- Forest-type maps
- Ecology
  - Identification books

Soil Survey Manuel

SCS soil memos

Maps
- Small scale
  - AMS aerial photos at 1:70,000 scale
  - Topographic USGS quad sheets at 1:62,500 scale
  - Road maps

Large scale
  Aerial photos at 1:20,000 scale, 1:15,000, 1:12,000 or larger
  Topographic USGS quad sheets at 1:24,000 scale

Equipment

Vehicles
- Cars, pickups, jeeps
- Trail scooter8 - such as Tote Gotes

Stereoscopes
- Pocket, mirror, and scanning types

Shovels, bars, picks, maddocks, augers, geologist pick

Abney level

Compass

Binoculars

Increment borer

100-foot tape

Diameter tape

Carpenter mechanical rule - 72 inch

First aid kit

Meld pack

Knife

Munsell color book and field notebook

Forms
- Soil profile
- Vegetation
- Range
- Timber
- Engineering

Monolith equipment

PRELIMINARY OFFICE STUDIES

The main product of preliminary office studies in this discussion is the small scale schematic or exploratory soil map as defined in the Soil survey Manual. This provides a means of testing adequacy of supporting materials such as geology. This schematic or exploratory map becomes increasingly important with decreasing accessibility. Difficult accessibility of forested and range areas is common and the exploratory soil map can be a step in the solving of this problem.

Other steps prior to the designation of soil boundaries on the small scale map are a study of geology, soils and vegetation by interpretations from photographs and other base maps, together with literature and accompanying maps. Included in this literature would be published soil survey reports, soil handbooks, official soil series descriptions, and geologic and vegetative publications. A legend for the soil areas would be developed during this mapping procedure. Broad geographic associations of soil series would be included in most of the delineated areas. Geologic and vegetative maps could also be developed at this time and preferably before the exploratory soil map is made.

Stereoscopic coverage as well as other photographic clues are furnished by AMS photos at 8 scale of 1:70,000. USGS topographic maps and simple line maps showing roads and drainages can also be used. Readily seen and usable details are shown on AMS photos and USGS topographic maps. These are the most usable maps for arriving at the schematic or exploratory soil map before a general field study is started.

Office preparation of maps would include recording of things in a manner that is both legible and reproducible. Some cartographic precautions are as follows:

1. Blue ink is not reproducible in most photographic processes. It also does not project when using an overhead projector for transferring lines. A few drops of black ink are added to each 3/4 ounce bottle of blue to overcome this.

2. The clearer part of the photo taken out of the center is used for the mapping area. One rule of thumb is to take the midpoint of the overlap as the boundary.

3. Preservation of the emulsion is important. When the emulsion is indented it reproduces through an overhead projector even though any accompanying pencil line is erased.

Delineating the mapping area of both the small scale and large scale base maps that are normally aerial photos is important. Other office preparation of maps includes location of section corners, designating township and range, showing adjoining photo numbers on the edge of each map. Preliminary soil boundaries may also be placed at this time by use of the stereoscope and other interpretations and. literature.

PRELIMINARY FIELD STUDIES

Preliminary field studies are a help to organizing the soil survey. The reconnaissance map is a result of exploration of the area by use of all roads and other transects. This is the second stage of small scale mapping and is a refinement of the exploratory soil map. Detailed studies of sample areas ranging in size from 400 to 1,000 acres 'are used, in addition to road transects. Geographical associations of soils are determined from these detailed studies as well as distribution and relationships of individual soils. Both the legend for the reconnaissance map and. the detailed map' are developed during these detailed studies, However, this is only the initial legend for'the detailed map and changes and additions are made throughout the survey.

A system for taking and filing field notes is essential. Soil profile descriptions, mapping unit descriptions, and soil use and management are major categories for note taking. These field notes are the basis for a soils handbook which is a summary and interpretation of the field notes. The soils handbook consists of a descriptive legend for the detailed soil survey, the reconnaissance map, and a soil use and management section.

FIELD MAPPING

Field mapping here considered is in connection with making the detailed large scale soil map. It consists mainly of checking preliminary soil boundaries that were arrived at by office studies, and the placing of additional soil boundaries in the field. Certain features are also recorded on the aerial photos such as trails and structure. Transects are made by trail, road, compass line,, and other means.

The basis for the detailed soil survey is the initial legend made during the course of the reconnaissance. The mapping units and taxanomic units are described and identification symbols for use on the large scale maps are designated. Preliminary soil boundaries are placed by using the reconnaissance map, stereoscopic viewing, and other means in the office. All roads and trails are used in transecting the area. Line transects are also used. These line transects are sometimes paced and tho information recorded, These recorded line transects give information on composition of the mapping unit and aids in predicting similar units of other areas. Reliability of the detailed map is indicated by recording ail transects 'by marking routes and dates on a line map. Preliminary soil unit boundaries are revised and additional boundaries are added as these transects are made.

Some items that need to be considered in the detailed soil survey are enumerated as follows:

1. The 'base maps should be well preserved since their legibility and use to reproduce a final map presents problems. Certain cartographic principles must be adhered to as outlined under the detailed map section.

2. Precise taxanomic unit descriptions are needed with related data recorded. Locations of modal profiles should be recorded end sampled profiles located on the photograph.

3. Mapping unit descriptions are needed before the general field mapping is started. These descriptions are revised throughout the course of the survey by recorded transects and other observations. Each mapping unit should have a location for the typical exemple.

4. Symbols should be designated and defined, 'both for the mapping units and other features that are to be recorded on the map.

DERIVED MAPPING

A generalized soil map, as defined in the Soil Survey Manual, is the result of delineations on a small scale map by geographic associations or combinations of units from the detailed map. This map would be used principally when large areas are considered for use and management planning.

SOILS HANDBOOK

The Soils Handbook is 8 summary and interpretation of the field notes. Among the items it may contain are:

1. The descriptive legend with an identification legend for the mapping units, general soil series descriptions, and. descriptions of the mapping units for the detailed soils map.

2. A reconnaissance map with legend and description of the geographic associations.

3. A soil use and *management* section.

Describing and Naming of Units of Classification

When soil individuals have similar layers they are grouped into a class called a soil series. The soil series name plus the surface soil texture is a soil type - the lowest category in the system of classification. The soil series or soil type is the basic unit used in mapping soils. Soils Memorandum SCS-11 outlines form and content for official soil series descriptions and procedures for processing. We should probably make a distinction here between the official soil series description in SCS-11 and a more generalized series description for a descriptive legend. Tine official soil series description includes the range of a soil for nation-wide correlation purposes while the series description for a specific area for a descriptive legend is applicable mainly to the one area with a certain range in soil characteristics. The soil series is described in the field using a field form (SCS 235 and FS 2500-l) for recording significant features. When several profiles have been described a narrative description is then made up describing 'the range in characteristics and other features. For a descriptive legend the soil series descriptions may include the following:

Depth Class	Slope
Drainage	Vegetation
Parent-Material	Use
Narrative Soil Description	Simple Profile Description
Depth to Restricting Material	Here or Under Mapping Unit

Describing and Naming of Units of Mapping

With the soiltype or soil series as a base, units of mapping are designed.. The mapping units are not units of classification but are areas delineated on the soil map. Several kinds of mapping units used are as follows:

The soil series or soil type	The soil complex
The soil phase	The miscellaneous land type
The undifferentiated group	Soil associations

The Soil Series or Soil Type - When the soil series or soil type is used as the mapping unit, it has the same name as the unit of classification. However, they are not the same. The mapping unit is the area mapped; and while it is composed mainly of soils that are within the limits of the unit of classification, other soils make up an area of less than 15 percent within any delineated area.

The Soil Phase - This is the mapping unit most commonly used in detailed soil surveys. The soil phase is designed for applied objectives, but it is tied to units of classification for purposes of organizing and interpreting our facts. It is always named in terms of a subdivision of a unit of the classification system - most often as a subdivision of the soil series or soil type, but it can be applied to any unit of classification. Like any mapping unit, it has inclusions of other soils.

The Undifferentiated Group - This is a mapping unit named in terms of two or more units of classification or phases of them. The unit consists of any one or all of the components - the composition is not predictable and the difference between the units of classification is not significant for applied objectives.

The Soil Complex - This is a mapping unit of detailed surveys for areas in which two or more soil bodies of different kinds are so small and interspersed that they cannot be mapped accurately or present excess detail at the scale used. The composition of this unit is predictable and it has inclusions of soils besides those named.

The Miscellaneous Land Type - This kind of unit is used for areas that cannot be classified. Rocky areas with little soil or inaccessible areas are among the types Of areas.

Soil Associations - These are units of mapping commonly used in reconnaissance surveys at a small scale. They are like the soil complex in that each soil unit consists of two or more classifiable soils that are associated in relatively consistent proportions and patterns. They differ from soil complexes in that the individual soil bodies of the constituents are mappable at the normal scale of detailed mapping.

In the description of a mapping unit use the first sentence to describe the unit by the major soil components and the position on the landscape. Minor soil components or Inclusions of other soils should be noted, their position in the landscape described, their range in size of areas given, and. their range In percentage composition of the unit estimated. The modal composition of the unit needs also to be given together with a type location for the mapping unit. A statement on how the unit differs from like units is helpful. To obtain the composition of a unit transects are made. A procedure for making transects is described in Soil Survey Field Letter (USDA, SCS) of June 1961. Records of transects should be recorded. Included in these records should be location, compass direction, mapping unit identification, record

Compaction and Trafficability
Windthrow Hazard
Erosion Hazard
Species Adaptability
Major Management Problems
Special Problems
- Pack Stock Forage
- Hikers, Hunters, Winter Sports, Water Sports, Fishing

Drain Field Suitability

Range:
Limitation and Reason
Drainage Class and Slope Characteristics
Depth to Water Table or Restricting Material
Compaction and Trafficability
Erosion Hazard
Species Adaptability
Major Management Problems
- Reseeding

Game Use Related to Livestock Use

Timber:
Productivity, Limitations, and Reason For
Cover Type and Revegetation
Seedling Mortality and Plant Competition
Equipment Limitations
Windthrow Hazard
Roads

Water:
Moisture Relationships
Sustained Water Yield and Peak Flow
Soil Stabilization
Road Stabilization
Nature and Thickness of Geologic Materials

Wildlife:
Practices Applicable to Water
Type Wildlife Habitat
Compaction
Drowse Management
cover Type
Special Problems
- Game Dispersion
- Logging Practices
- Roadside Seedings

Engineering:
Physical analysis of soil related to compacting, stabilization and moisture relationships.
Water relationships such as sustained water yield and peak flow.

CORREIATION

Correlation consists of the naming and describing of units of classification and units of mapping., This basic step has a8 its objective uniformity, both in the local survey area and other areas of similar conditions.

An initial field review is made prior to or shortly after field mapping for the detailed map is started. This is followed by progress reviews throughout the course of making the detailed map. A final field review is held after mapping is completed.

A field correlation is the report for the final field review, It is followed by an intermediate correlation at the Regional level. The final correlation is the Washington, D. C. office recommendations.

SOIL SAMPLING

Soils are sampled for office reference by the soil correlator. These are called correlation samples. Samples are also taken for engineering analysis, special studies, and soil characterization.

WESTERN REGIONAL TECHNICAL

III. Officers.

A. Chairmen and Vice-Chairman.

A chairman and vice-chairman of the Conference are elected to serve for two-year terms. Election6 are held during the biennial business meeting. Election of officers follows the selection of a place for the next meeting, because officers must be from the State where that meeting is to be held. Officers rotate among agencies. That is, the chairmen-elect must be of a different agency than the past chairmen. Similarly, the vice-chairman must be of 6 different agency than the chairman.

Responsibilities of the chairman include the 'following' (specific tasks may be delegated to the vice-chairman):

1. Planning and management of the biennial Conference.

2. Function as a member of the Steering Committee.

3. Issue announcements and invitations to the Conference.

4. Organize the program of the Conference, select presiding chairmen for the various sessions, write the program, and have copies of the program prepared and distributed,

5. Make necessary arrangements for lodging accommodations for Conference members, for food functions, for meeting rooms (including committee rooms), and for local transport on official functions.

6. Obtain official clearance for the Conference from SCS and Experiment Station officials.

7. Assemble the Proceedings of the Conference, have them duplicated, end distribute them,

8. Provide for approrpiate publicity for the Conference.

9. Preside at the business meeting of the Conference.

10. Maintain Conference mailing list and turn it over to incoming chairman.

Responsibilities of the vice-chairman include the following:

1. Function as a member of the Steering' Committee.

2. Act for the chairman in the chairman's absence OK disability.

3. Perform duties as assigned by tho chairman.

III. Officers (continued)

B. steering Committee.

A Steering committee assists in the planning and management of biennial meetings, including tha formulation of committee memberships and selection of committee chairmen. The Steering Committee consists of the following members:

Principal Soil Correlator, Western States (chairman)
The Conference chairman
The Conference vice-chairman
The Conference past chairman

(See Appendix A.)

C. Advisors.

Advisors to the Conference are an SCS State Conservationist (usually, not not necessarily, from the State where the Conference is held) and an Experiment Station Director (usually, but not necessarily, from the State where the Conference is held).

D. Committee Chairmen.

Each Conference committee has a chairman, Chairmen are selected by the Steering Committee,

IV. Meetings.

A. Time of Meetings.

The Conference convenes every two years, in even-numbered years. It is held during the last full week of Jsnuary.

B. Place of Meetings.

The Conference may be held at any suitable location. During the biennial business meeting, invitations from the various States are considered, discussed, and voted upon. A simple majority vote decides the location of the next meeting.

V. Committees.

A. Most of the work of the Conference is accomplished by duly constituted official committees.

V. Committees (continued)

C. The kinds of committees, and their members, are determined by tlu Steering Committee. In making their selections, the Steering Committee makes use of expressions of interest filed by the Conference members.

D. Each committee shall make an official report at the designated time at each biennial Conference. Committee reports shall be duplicated and copies distributed as follows:

One copy to each member (whether present or not) and participant in the Conference
Twelve copies to the Director, Soil Survey Operations, SCS, for distribution to other regional conferences and their committees.

Note: Chairmen of Committees are responsible for submittal of committee reports ptomptly to the Chairman of the Conference. The Conference Chairman is responsible for duplication and distribution of committee reports.

E. Much of the work of committees will, of necessity, be conducted by correspondence between the times of biennial conferences. Committee chairmen are charged with responsibility for initiating and carrying forward this work.

VI. Amendments.

Any part of this statement of purposes, policy, and procedures may be amended at any time by simple majority vote of the Conference permanent voting membership.

January 1964

APPENDIX A

THE STEERING COMMITTEE
of the
WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE FOR SOIL SURVEY

I. Membership.

The Steering Committee consists of four members, as follows:

Principal Soil Correlatot, Western States (the chairman)
The current (or forthcoming) conference chairman
The current (or forthcoming) conference vice-chairmen
The immediate past conference chairman

Membership changes upon election of officers at the regional work-planning conference.

II. Meeting6 and Communications.

A. Regular Meetings.
At least one meeting is held at each regional work-planning conference. Additional meetings may be scheduled by the chairman if rho need arises.

B. Extra Meetings.
Meetings of the Committee may be held between regional conferences if convenient and necessary.

C. Communications.

III. Authority and responsibilities (continued)

B. Conference committees and committee chairmen (continued)

2. The Steering Committee is responsible for the formulation and transmittal to Committee chairmen of charges to committees.

C. Conference Policies.

The Steering Committee is responsible for the formulation of statements of Conference policy. Final approval of such statements is by vote of the Conference.

D. Liaison.

The Steering Committee is responsible for maintaining liaison between the regional conference and (a) the Western Regional Soil Survey Work Group, (b) the Western experiment station directors, (c) the Western state conservationists, (d) the national and state offices of the Soil Conservation Service, (e) regional and national offices of the Forest Service, the Bureau of Indian Affairs, and the Bureau of Reclamation, (f) the Western Soil and Water Research Committee, and (g) other cooperating and participating agencies.

Remarks to the Conference by

Dr. S. P. Gessel

I should like to briefly account to you the history of development, and the objectives and current activities of the Pacific Northwest Forest Soils Council; This organization was initiated in 1948 as the Forest Soils Committee for the Douglas Fir Region. It was initiated at about the time that foresters were beginning to take interest in soils and soil science as being important in forest management programs. Before this time there had been very little soils research done on forested soils;

The initial objective of the Council was to bring together professional people in the northwest, who were interested in working with or learning about forest soils. The northwest area at that time was considered as the West Coast of Washington, Oregon, and northern California. Since its inception, the Council has enlarged its geographic area of membership to include Idaho, and Montana, and all of California, Oregon, Washington and British Columbia in Canada.

Other objectives of the Council were to develop interest and organize programs in research on forest soils, to further teaching of forest soils at colleges and universities, and to educate the general public about forest soil management. Most colleges and universities in the western states now have a teaching and research program in forest soils; Most curricula in forestry schools or departments of colleges and universities now have courses in forest soils.

The Council holds two meetings each year, a winter business meeting, and a summer meeting having a field tour covering some phase of forest soil research or management; The summer field meeting in June 1964, will review the soil survey program of Weyerhaeuser Company;

The Council has produced one publication, an introductory manual to soile of the Douglas Fir Region. This manual has had two printings; A second manual is being edited for publication which will embody analytical methods for use in studies of forest soils. This has been in part due to some difficulty in using methods of analysis developed for use on agricultural soils when working with forest soils,

The Council started out as a small group; Often small groups accomplish more activities than large groups. As the Council has grown, the activities have changed more to discussion and conference than actually activating projects.

The Council was created at about the same time as section Va, now section VII of the Soil Science Society of America Proceedings was established, This has helped the Council encourage publication of information about forest soils. The Council has close ties with the Society of American Foresters, through its officers and membership. There is some interest in development of other regional councils in Northeast, Southeast, North Central parts of the United States. Some discussion has ensued within the Council relative to petitioning the Society of American Foresters for a forest soils section in their Journal. This can be helpful since all foresters do not receive SSSA Proceedings;

The Council has assisted the series of North American Forest Soils Conferences by sponsorship assistance, contributions of papers, and assistance in arranging field tours; Assistance has also been given to the western section, SSSA, in contribution of papers, and arrangement of field trips;

Some of the questions currently being considered by the Council are:

Do we still have need for the Council? Can it still be of assistance to the teaching, research and education programs in soil science, forestry, or forest eoile? What is a valid future program for the Council?

There eeeme to be no lack of interest on the pert of foresters for knowledge and data about forest eoile. There is need to prepare basic information about soils for their use.

Question: C.E. Kellogg, Do you feel there is need for Regional and National Conferences about Forest Soils? What of the possibility of SSSA and SAF jointly sponsoring National Conferences on Forest Soils?

Answer: C.T. Youngberg. SSSA, SAP and two Canadian Societies are working toward a formation of committee for the next North American Forest Soils Conference.

THE MORPHOLOGY, GENESIS, AND CLASSIFICATION OF ALPINE SOILS IN WESTERN MONTANA

by R. C. McConnell

Purpose: Bring to attention proposed Great Soil Group of Alpine Soil series with unique climate, landform, vegetation, and animal life.

This paper will summarize the data collected on Alpine soils in Montana during four field seascme. A paper will be prepared for publication by Dr. Nimlos and McConnell which will present this in greater detail, The data represent the major cooperation effort between Montana State University and the U.S. Forest Service, initiated by Dr. R. Taber, MSU* under NSF grant, and continued by Dr. T. Nimlos, MSU, and R.C. McConnell, USPS.

1. The Alpine Environment

A. Definition of Alpine; ecosystem above timberline which has been modified by frost action; The subalpine is a transitional ecosystem between the alpine and montane forest. Elevations at timberline in Montana range from 7600' in Glacier Park to 9200' on the Beartooth Plateau.

B. Vegetation[1] consists of shrubs, sedges, grasses, and forbs. Lichens, mosses, Selaginella, Deschampsia, Poa, Trisetum, Carex, Junceus, Salix, Polygonum, Claytonia, Arenaria, Geum, Dryas, Vaccinium, Sedum, Borage, Erigeron, are some of the species represented and include 34 families and over 200 species.

C. Climate

1. Temperature: Wean annual air temperatures have been estimated at 30°F. The Montana areas can be related to extensive climatic records for the Colorado Alpine[2]. Dr. T. Nimlos is currently making a moisture-temperature study to be reported later.

Air Temp., degrees F.

Max.	61 to 64
Min.	-20 to -15
Mean	25 to 28

Soil Temp., 6" depth, degrees F

Wax.	59 to 53
Min.	8to 2
Mean	21 to 29
12 depth mean	29 to 31

Wind Velocity

Total miles	139,715	to	141,018
M.p.h.	16	to	18
Precip. (in.)	26	to	34

[1]Plant Ecology of Alpine Tundra Areas in Montana and adjacent Wyoming. Samuel A. Bamberg, MA 1961, University of Colorado.

[2]Ecosystems of the East Slope of the Front Range in Colorado.

*John A. Merr; Institute of Arctic and Alpine Research, Univ. of Colorado, Proposal for Research on Ecology of Alpine Communities in the Northern Rocky Mountain Area.

2. Precipitation. Since air temperatures are low, most of the precipitation comes as snow which is unevenly distributed.

3. Wind. The wind movement is important to ecology of the Alpine causing deformation of plants, erosion, and uneven distribution of snow and related moisture.

4. The interaction of wind, moisture, and snow cover is associated. according to Bamberg[1], with a mosaic of stnads with sharp boundaries, "Patches" or units of change are associated with interactions involving soil frost, plant cover, insects, mammals, wind erosions, frost action, snow, and running water. Aid No. 1, Triangle of Ecosinfte.

   Increase of wind action ranges from snow accumulation stand type through wet and dry carex meadow stands to fellfield or wind exposed stands where snow blows off and moisture is low,

   Increase of moisture ranges from fellfield (low moisture) through dry to wet carex meadow to carex-hummock stand types in wet alluvial areas.

   Increase of snow cover ranges frommoderate amounts in carex-hummock stand type through carex-willow, deschampsia meadow to persistent snowbank cover areas with no vegetation, Fellfield wind exposed areas have little or no snow cover.

5. Animals[2]. Small mammals are not randomly distributed, but they occur in distinct assemblages related to certain habitat types. For instance, gopher activity occurs under certain snow accumulation positions. Pica and marmot graze the immediate vegetation around burrows and rock piles. White-footed deermouse is common; gopher disturbance is widespread; microtines live along small streams, grass and sedge meadows, and hummocks. Shrews are found in rock polygons and in boggy areas. Flies, mosquitoes, grasshoppers, moths, beetles, and soil mites are found. Pipits, ptarmigan, rosy finches, hawks, eagles, and falcons are found.

6. According to analysis made by the Upjohn Company of soil organisms on Beartooth Plateau, bacteria were common, but fungi and actinomycete groups were mainly absent. The implications of this are not know, but it may be related to a distinctive type of humus formation,

II. <u>Background to Study</u>

A. Part of a "total environment" study to characterize the alpine ecology on eight study areas from east of Yellowstone Park in the south to Glacier Park in the north.

B. Fifty-three profiles were described and sampled on the eight areas. Later in 1962, paired samples of three representative series on Beartooth Plateau and Big Snowy Mountains were sampled in cooperation with SCS for the Lincoln Laboratory. Their report has not been fully released as of this date, but a tentative report is being assembled.

III. <u>Summary</u>

Alpine soils in Montana have organic surface horieons over Al horieons in well drained soils, and Ag horizons in poorly drained soils. The absence of an

[1] cf., Bamberg 1961

[2] cf., Bamberg & Taber 1961

A2 horizon contrasts with alpine soils in the Alps and some alpine soils in Alaska. A variety of Lower horizons occurs, depending upon the parent material and the internal drainage. The accumulation of organic matter is due, at least in part, to low temperatures, While ice lenses were found in some profiles, early in the summer permafrost was not oberved. Similar clay minerals were found in the surface horizons and in the coarse fragments, indicating very mild weathering.

Slides

1. Long distance shot of alpine on Crazy Mountains;
   Note: The upper and lower timberline with Montana forest in middle.

2. Landscape of alpine areas - Yogo Mountain, Little Belts
   Note: Most alpine areas occur as isolated islands on steep peaks that are above the general body of mountains.

3. Landscape of large alpine area - Beartooth Plateau.

4. a. Close-up of vegetation,
      Note: Cushion plants on exposed area to right and sedges and grasses in slightly protected area to the left, where snow can accumulate.
   b. Krumholz - wind suppressed and deformed trees.
   c. Subalpine - Glacier Park;
      Soils of subalpine have not been investigated.

Three soil series were found to occur in the alpine of Montana.

IV. The Soil Series

A. Ptarmigan series composed of well drained, acid, stony alpine soils, found in quartzite or other metamorphic rocks, including gneiss and schist, Its morphology is 02 (turf) Al, B, C (Slide 5 of Ptarmigan profile).

1. 02 - The organic carbon is a borderline value between an organic and inorganic horizon. (Mean of 13.6; range 8.8 to 18.9 percent.) It is called an 02 to accentuate its organic nature. This horizon has a C/N ratio of about 13, base saturation of over 90 percent (Slide 6 on turf overhanging) yet are medium acid (pH 5.7; range 5.3 to 6.4). Why this high base saturation with low pH we cannot explain.

2. Al. The Al has a similar C/N ration, base saturation, and pH. Also, the percent organic matter is high. (5.7% x 1.724 = 9.8% OM.)

3. The B horizon is mainly similar to a Bir horieon which may indicate that the tree line may have been much higher. (LOTS 4/3 - 5/6 M 4/4 - 5/4 D) Coarse fragments may range from 40 to 80 percent. Brown colors due mainly to iron.

4. Soil genesis includes organic matter accumulation on the surface; some translocation of organic materials; minimal trenslocation of clays, translocation of sesqueroxides in most profiles; accumulation of silt on tops of coarse fragments in the profile.

5. Evidence of organic alluviation are the organic stainings on the undersides of the coarse fragments. (Slide - organic stainings on undersides of coarse fragments, and silt accumulation on upper side of rock fragments,

6. **Mineralogy**[1]. Vermiculite, biotite quartz, feldspar in 02 - Al, B. and C. One profile on Siyeh Pass, Glacier National Park, showed illite chlorite, keolinite, quarte feldepar, and this may indicate need for another series based on a different mineralogy, No significant volcanic glass was observed in any of the soils examined;

7. Physical and chemical analysis (means) clay 5 to 6 percent; pH 5.7 to 5.4; Nitrogen 1 to 0.02; Carbon 13.6 to 0.3; C/N 12.6 to 16.6; Calcium me. 24 to 13; Mag. 4 to 0.2; Potassium 1 to 0.2; Sodium 0.1; CRC 31 to 5; Percent Base Saturation 97 to 42; free iron percent 1.5 to 1.2; available phosphate ppm 122 to 10.

8. Classification - Great Soil Group - Alpine turf as defined by Retzer.

9. Landforms. Origin apparently related to frost action.

   a. Polygons. Slide 8a of Y-polygons; Slide 8b, close-up of polygons on Yogo Peak.

   b. Stripes - slopes counterpart of polygons. Slide 8c, and 8d, polygon fields, Beartooth Plateau.

   c. Terraces. Small microterrous, 6-inch risers - Slide 9, Siyeh Pass, Glacier.

   d. Rockplow. Slide 10, rockplow and #11a profile in lip; matches in 11a are buried turf horizons; 11b, solifluction terraces; 11c 6 11d, incipient polygons; 11e, Gravelly snow field after melt; 11f, snow pattern and bare gravelly areas.

10. 7th Approximation Classification:

    Chemical data indicate surface horieons have low C/N ratios and high base saturation and are therefore mollic. Cambic or spodic horizons may be present. Proposed names are normic cryorthods or intergrades to boric cumulic hapludolls. Cryudola, a new group, is also proposed.

B. Hopleya series includes well drained alkaline, cobbly, alpine soils formed in limestone. Its morphology is O_2, A_1, C_{ca}. (Slide 12, Hopleys Profile)

1. O_2. The turf and A_1 horizons are similar to the same horizons in the Ptermigan series in organic levels and C/N ratios but differ in being alkaline.

2. C_{ca} horizon indicated definite accumulation of calcium carbonate.

3. Mineralogy. A to C_{ca}, Montmorillonite, chlorite, quartz, feldspar.

4. Physical and chemical analysis. (Means) Clays 10 to 21 percent; pH 7.5 to 7.9; percent N. 1.4 to 0.05; percent carbon 14.8 to 0.6; C/N ratio 10.6 to 18.3; Potassium me 1.9 to 0.3; Sodium 0.1; available phosphorus ppm 26 to 54.

5; Genesis. The same evidence of mild weathering occurs within the Hopleye profiles. Genesis is limited to the accumulation of organic matter and some precipitation of calcium carbonate into a C_{ca} horizon,

[1] Hower, MSU Geology Dept., MSU

6. Classification. The Hopleys series is also a member of the Alpine great soil group.

7. Landforms. The moat unique landform is the Dryae Island, a pattern of small islands of vegetation, predominately Dryas spp. in a sea of gravel, The profiles in the vegetation and in the gravels are the same except for the 0_2 missing in the gravele. (Slide 13, islands, and 14 mounds.)

C. Beartooth series include8 poorly drained, strongly acid alpine soils formed in alluvium of mixed rocks. (Slide 15, Beartooth profile).

1. Its morphology is 02, A_g, G.

   a. 0_2. This is a definite histic horizon with organic matter contents well above minimum levels for histic horizons. Base saturation is about 50%; C/N ratios are over 20.

   b. The horizons below are variable, from weakly to strongly gleyed and with evidence of frost action disrupting the profile.

2. Genesis. Similar to other poorly drained soils, with stagnation of organic matter on the surface and gleying and/or mottling throughout the profile.

3. Physical and chemical analysis; (Means) Clay 4 to 5 percent; pH 4.6 to 5.1; percent N. 0.78 to 0.24; percent carbon 17.3 to 3.7; C/N 22 to 15; Calcium me. 11.6 to 2.6; Magnesium 2.0 to 0.8; Potassium 0.9 to 0.1; Sodium 0.2; CEC 11.0 to 4.7; Base Saturation 54.5 to 70.0; available phosphorus ppm. 76 to 24.

4. Landforms (Slide 16, Carex hummock; Slide 17, Landscape near lake)

5. Classification. Alpine bog great soils group as defined by Retzer.

D. Conclusion:

Slide 18, Alpine landscape and alpine bog

Slide 19, Ptarmigan birds

Slide 20. Niwat Ridge "birds"

Slide 21. Alpine Landscape

Report of the Research Work Group

Mr. Chairman, Members of the Conference

At our last conference at Las Cruces, the Steering Committee recommended the establishment of a "Work Group" for the purpose of collecting, assembling and distributing inventories to the members of the Conference; This was one of the objectives of Committee 6, Soil Survey Research; It was also recommended that the work group collect the data that was recommended for collection by committee No; 10, Soil Moisture, The Steering Committee further recommended members of the Work Group consist of the following: LeMoyne Wilson, Chairman, with G. H. Simonson and T. B. Hutchings.

The conference group approved the recommendations. This Work Group in effect was assigned the work of both Committee 6 and 10 of the Las Cruces Conference.

Although the collecting and assembling of laboratory inventories was only one of the objectives listed in the report of Committee 6, it proved to be a sufficiently large assignment for the Work Group. Our original target date for completion of the inventory was August 1962; We didn't meet that date. The next target date was January 1, 1963. Again we didn't meet that date. I believe Arizona and Nevada were the only states that responded by that time.

During 1963 and early 1964, inventories have been coming in and we now have inventories from 9 states; Colorado and California have not yet provided inventories; We have 60 copies of these inventories here at the conference.

As I recall, we developed a distribution list for the 60 copies of the Inventory. I don't have that list, and if the secretary of the Las Cruces Conference doesn't have it, or if no one else here has the list, we will need to develop a new one;

We haven't yet developed any kind of a statement to accompany the inventory. That is something we need to develop here at the conference;

I believe there is some differences in the inventories from the different states that will need to be brought out; for example, the Utah Inventory consists of a selection of 260 soils that we think shows a central or modal concept of the series and it represents data and descriptions that we would be pleased to release to anyone who has need for it. We have a large amount of additional data that we would rather not release at this time.

The Arizona inventory is also only a partial inventory representing modal conditions of the series,

Inventories from some of the other states appear to be more complete. We will want to contact representatives from each state during the conference to find out just what the inventories represent.

Some of the states brought their inventories with them to the conference. We will insert these into the report &ring the conference and hope to have it ready for distribution before the conference ends.

One thing we did at the last minute was to request a priority list of Bench Mark soils from each state. This was one of the objectivee approved for the committee 6, Soil Survey Research, but was not included in the change to the Work Group.

Lemoyne Wilson, Chairman
G. H. Simonson
T, B. Hutchings
Maynard Fosberg
William M. Johnson

The Soil Survey Program of the Weyerhaeuser Company

by

E. C. Steinbrenner

I have been asked to talk about the soil survey program of the Weyerhaeuser Company which I will do for the naxt 30 minutes. Although we are conducting soil-vegetation surveys on our Klamath Falls Tree Farm in the pine region of south central Oregon, I am going to concentrate on our soil-landform mapping in the fir region of Washington and Oregon;

You are probably wondering how and why a private timber Company such as Weyerhaeuser has become involved in a large-scale soil survey program. Many factors have contributed to this development and I will attempt to mention just a few by way of background.

First of all, Weyerhaeuser Company has been one of the most progressive private timber companies in forest management. Not only did they early recognize the value of sustained yield forestry and originate the tree farm movement in the United States, but they have pioneered industrial forestry research. Our Forestry Research Center at Centralia, Washington began on a small scale in 1942. Early research dealt mainly with regeneration, stand improvement end growth and yield studies. As thfe work progressed, it became more and more evident that there was a need for research specialists in the allied forestry fields. In 1951 a soils specialist was added to the staff followed in 1952 by an entomologist. By 1956 specialists in wildlife management, pathology and physiology had joined the staff. Genetics work began in 1962 to round'out our present forestry program that includes research in nine fields.

Our present staff includes a director, nine project leaders, six technologists, editor, statistical clerk, two laboratory technicians and secretarial help. During the field season we employ five summer assistants. Although, not very deep in man power in each field, the close cooperation between project leaders strengthens the research work. For Instance, our soil-site studies are in cooperation with the growth and yield project, thinning and fertilizer studies are in cooperation with the silviculture project and our work on tree nutrition is in cooperation with the physiologist.

Weyerhaeuser Company has been well aware that the soil rather than the timber is its basic resource. Very early in the operation of the Research Center it became obvious that in addition to specific soils problems, the application of research results in general would be extremely limited without a survey to inventory the location and extent of our major soil series. Working as we do in very close cooperation with the foresters on our tree farms, the research staff is fully aware of the needs of the foresters in the field; We are in a good position to know which interpretations of the soil survey are necessary for the management of the lends and can set our goals and objectives accordingly. In the same way, we are able to ascertain the present intensity of forest management practices and anticipate future advances. This knowledge ha8 a direct application to our soil surveys, determining the kind and amount of detail that is mapped.

Although we began our soil survey in western Washington in 1959, preparations or background for survey work began in 1954 with the initiation of our soil-site work on Douglas fir. We felt that it was necessary to have some data wfth which to interpret the soils information for forest management before we began a survey program. Soil-site work for Douglas fir had progressed to a point where it was useful in setting up the legend and also for the prediction of productivity of the sampling units. Previous soils research on windthrow and tractor logging problems was also available for interpretation of the mapping units in terms of these special problems.

Our first soil survey was on the Snoqualmie Falls Tree Farm in eastern Ring County; This was a plot survey in cooperation with Warren Starr and Ray Gilkeson of the Washington State University; Warren and Ray had Initiated the use of the soil-landform method of forest soil survey. The Snoquelmie Falls Tree Farm was chosen because it encompassed both glaciated and mountainous topography, was 8 rather compact unit and was of sufficient size--244,000 ecree--to adequately assess the economics of this type of survey. We considered this survey in the realm of research 8s we had to determine the adequacy of the method for forest management use before entering into a full scale survey program.

Field work on this survey was accomplished between June and October of 1959. Following some delays in the office work and cartography, we published the report in 1961; Happily, we found that this method of soil survey was more than adequate for our management purposes and was very economical. The mapping units were tested and found to be quite uniform and accurately located; But more on these tests 8 little later.

With the acceptance of this report, we embarked on a full scale soil survey program for Weyerhaeuser lends in Washington and Oregon. Mr. Fred Geheke was transferred from our Klamath Falls Tree Farm to our Research Center and spends full time on soil survey. Fred joined us in June, 1962 and in July we began our reconnaissance work on the Veil Tree Farm in eastern Lewis County. The field work on the 433,000 acre unit was completed in Way, 1963. The cartography is now completed and the report on this survey ahould be published by Watch. We are currently mapping the McDonald Tree Farm, 8 336,000 acre unit in western Lewis County.

Our soil survey program will call for mapping a total of approximately 4,300,000 occasionally on the ridge tops, but primarily on the gentle slopes and benches. In some cases an alluvial soil is included in the association. The colluvial series is separated from the residual on two main characteristics: the presence of rock or gravel throughout the profile and the lack of a well developed structure in the B horizon. The soil association is usually named after the residual series; Not all of the series in an association occur on all slopes, however. all of the series will occur within a geographic province with similar geology. Residual soils occur mainly on the broader ridges, on benches or on the gentler slopes. The colluvial soils are the most extensive and productive of our upland forest soils. We find the greatest variation in soil depth and gravel content in these colluvial soils. However, in mapping soils with landform we use a series of slope phases that account for a great deal of these variations. Using the soil-associations and natural slope breakdowns, we rarely need to resort to depth and gravel phases.

Using the Vail Tree Soil Survey which was just completed as an example, on three of the soil associations which included 40 percent of the area (170,900 acres) we find that 22 percent are in lithosol, 26 percent are residual and the remaining 52 percent are in the colluvial soils;

Our primary concern in mapping is uniformity. We must have uniform mapping units if our interpretations are to be applied with little variation. Unfortunately, uniform conditions, as you wall know, do not occur on all mapping units. We hold our complexes to a minimum and where there is variation or inclusions within a mapping unit, we attempt to describe these variations in explicit detail. We map only pure series, we do not recognize "soil types" as texture has too great a significance in forest soil management. These textures are all based on the "B" horizon where present or the 10 to 30 inch depth wbere there is no "B" development. A soil type vould not occur too frequently in upland soils as other characteristics seem to change a great deal with changes in subsoil texture;

In forest land mapping it is quite necessary to delineate the topography as well as the soil. Topography has great importance in such management aspects as harvesting, thinning and windthrow as well as productivity relationships. Warren Starr and Ray Gilkeson should be given the credit for pioneering the use of the soil-landform concept in forest-land mapping in this region. We have used this method exclusively in our mapping in the fir region and have yet to find an erea where it does not apply.

In our field examinations, I would estimate that we visit from 75 to 90 percent of the mapping units. Of course, this is quite dependent on the road system that has been developed on the tree farm. Most of our tree farms have been in operation for many years and have a rather extensive road system. Those units that are not visited are usually quite small.

Now I vould like to say something about the intensity of our mapping. We hold to a minimum of 5 acres for a contrasting unit and minimum of 20 acres for similar units. Inclusions up to 20 percent of the area may occur in a soil series. Inclusions that amount to over 20 percent of aree are mapped as complexes. Again, I would like to repeat, we try to keep complexes to a minimum.

Some soil surveyors insist on calling forest land surveys low-intensity or reconnaissance surveys. This may be true if one is comparing forest land surveys with the surveys produced for agricultural lands that are to be irrigated. We consider our forest soil surveys medium to high intensity from the standpoint of forest management. Although we do not draw a soil unit boundary on our maps that is not of some use in some phase of forest management, we realize that the intensity of forest management is ever increasing and the need for more detail may sometime become necessary. In our surveys, we have tried to anticipate the advances in forest management intensity and are mapping with sufficient detail for at least 20 years in the future.

As an example, let me use our recently completed Vail survey to illustrate the intensity of our forest land surveys; In this survey we find the following statistics:

Total Area:	433,000 acres
Total Soil Series Mapped:	57
New Series Mapped:	19
Miscellaneous Land Classes	5
Complexes (Soil)	20
Complexes (Soil and Rock)	25
Descriptive Soil Units	105
Landforms mapped	21
Modifications	6
Landform mapping units	41

Total Mapping Units-Soils and Landform - 372

The most extensive series covered 13 percent of the area; The next 9 moat e tensive series ranged from 6.5 percent to 3.7 percent of the area. The top 10 series covered 58.6 percent of the area; The 10 least (most) extensive series ranged from 406 to 748 acres each and accounted for 1.4 percent of the total.

Now I would like to talk a while about the details of our mapping techniques. The mapping is done on aerial photos at a scale of 1:12,000 or 1:15,860. We find that mapping unit delineations are much more accurate using stereo techniques and most of the boundaries follow quite closely the elevation contours. The maps are then reproduced at a scale of 2 inches per mile with a township per page; The base maps detail including contours is printed at 30 percent of black and the mapping units at 100 percent of black, Thus all physical features of the landscape, soils, landform, drainages, contours and elevation are on a single map; The complete survey legend is printed on the back of each map;

Following the field mapping, the modal soil of each series is located, preferrably in an undisturbed stand of timber; The soil is described and sampled for characterization. These soil samples, by horizon, are treated as research samples; The usual chemical analyses, NPK, Ca, Mg, Organic Matter, ph and cation exchange capacity are made plus the textural analyses and bulk density determinations; Several soil profiles are described for each series during the course of the survey but the modal soil is not selected until the field work is completed; At the time acreages are computed, the survey data are coded for machine analyses. The soils and landforms are assigned numbers which are entered on the code forms along with the location, acreage and a numerical code that has been assigned to each interpretation. I cannot go into detail on this coding procedure, but the forms and legend have been included in the packets we distributed; If there are any questions concerning this procedure, Fred Cehrke or I would be glad to answer them; We, so far, interpret our data into productivity, windthrow we have no need for this type of information and sort only for eight reports. We obtain a reproduction of our input data which is merely a reproduction of the code sheets in printed form which makes storage greatly simplified, a list of the total acreage by mapping unit which is a reproduction of our mapping legend, total acreage by site class and a report of each of the other interpretations by total acreage and location within each class; We have brought along a copy of these reports which you may browse through later if interested;

Machine sorting of the survey data is quit inexpensive; Our experience from two surveys show it costs about $ .70 per 1,000 acres of survey; For our eight reports it costs about $15.00 each for a printed original plus five duplicate copies.

determined largely from research-- will apply. We believe strongly that our ability to put research results into practice depends heavily on the soil survey and this is one reason for pushing it along as rapidly as possible.

1-24-64
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Remarks to the Conference

by Marvin D. Magnuaon

I had encouraged the group to visit a Weather Bureau office. I am sorry that you had to cancel this tour., The Weather Bureau also has an image problem. This image is characterized by the question, which we continually receive, as to how can we miss weather forecasting, with all the equipment we have at our disposal? Weather data collection and weather forecasting requires a vast communication system, with a great amount of recording equipment assembling data, and then considerable skill and experience to place the data in a central location, interpret its meaning, and put together a forecast.

A discussion of instrumentation is difficult, since we cannot bring the equipment here; The current, popular instrumentation for observance and recording of weather is the Tyros system. The eighth Tyros is now orbiting. The first Tyros was launched in 1960. This first Tyros lasted 27 days in orbit, and took 22,000 pictures; By the time Tyros 5 to 7 were launched, picture light had increased five fold, and 3 to 4 times as many pictures were producedi There has been a 99.9 percent success with these systems, end launchings have all been successful using the Thyrogenus? rocket. Future ones may employ the Saturn rocket.

The present Tyros is 400 miles out in orbit, has a box 24 inches in diamtter, housing two cameras. It is space oriented. It is a free body in space, and only in one third of its orbit is it in position to take pictures of the earth; The present system has a limited tape, only 64 picutres have bean produced. The satelite is affected by shape of the earth; The earth is pear shaped, and this affects picture taking of the satelite on its orbit; There is only a certain limited time the satelite is in position to take a picture; Pictures taken are of a 1000 square mile area. The meterologist has the picture taken now, and from it must forecast what the picture will be 48 to 72 hours hence.

The Weather Bureau maintains four stations on weather bureau ships. These are located along principal shipping lanes; There is still a vast ocean area which lacks any observation stations; Forecasters are obliged to use imagination and ingenuity;

Tyros is a good weather bureau tool; In addition to Tyros 8, some stations have systems for APT (automatic picture transmission). At anytime, by push button, a picutre can be taken at the area, transmitted, examined, and sketches made for field stations. We have an APT station on the roof at Seattle-Tacoma Airport. We can at any moment get a picutre above Seattle, Washington, There is a .1 percent error due to snow in the picture.

A later system series will be operating a satelite in polar orbit, orbiting at an 89° angle; This satelite will scan at all latitudes; It is earth oriented. It will be a revolving satelite also carrying meteorological censors. This unit will give better information and will receive energy from the sun. Solar energy in constant, and is the basic energy for weather. In answer to what is the weather we assert it is a forecast of events to come based on events of the past. As to why is the weather, we need more research to completely answer and to make a better forecast.

Bulletin W suppliment to Climatic Summaries for the United States, summarizes data on precipitation and temperature to 1952. This adds to the earlier suppliment which summarized data to 1931; There is yet another suppliment being prepared which summarizes data to 1961; Eventually, we hope to have a summary published each decade.

The Regional research project W-48 involves a regional analysis of precipitation and precipitation probability projected on a standardized weekly basis, Within the year, a publication should be available, covering these analyses. There will also likely be an Experiment Station publication in each state;

In answer to questions, Mr. Magnuson noted that there needs to be more work done on climatology for forecasting; Most forecasting done by meteorologists, and there is not sufficient information available about day to day changes in climate; The atomic explosions so far have had little affect upon the weather, since one thunderstorm in one half hour expands 8 to 10 times as much energy as a 100 M bomb. Atomic explosions generally do not produce nuclei of a quality to energize precipitation, Volcanic explosions, which emanate particles of matter, cause more nuclei to be formed and again, the quantity of effect in atomic explosions are still small when related to impact upon weather.

Committee Report No. 1

Criteria for Series, *Types,* and Phases

The committee understood that its charge was to consider the implicationa of the new soil classification system for series, types and phases; Three pertinent changes effected by adoption of the new system were considered.

1. Elimination of the type category;
   This committee agrees with the 1963 national committee that this change involves no apparent difficulties or problems.

2. Consideration of soil temperature and soil moisture as soil characteristics;
   This change has very controversial implications; The committee does agree on the following points:
   a. Temperature and moisture are important in themselves because of their relavence to interpretations and soil-vegetation relationships, in addition to their influence on the formation of developed morphology;

   b. Broad classes of soil temperature and eoil moisture important at the global level may need to be considered differently than the narrower classes of soil temperature and soil moisture that are improtant for interpretations and soil-vegetation relationships locally within soil survey areas;

   c. The most profound class limit may be the soil temperature below which plant roots cannot grow. This has been suggested to be about 42°F. (6°C). Soil material which does not get warmer than this limit is not available to rooting and therefore may be regarded as a limiting layer like bedrock or duripan. Soil classes based on depth to a cold limiting layer may be appropriate.

   d. Soil temperature and soil moisture information can be utilized for interpretations by considering it in addition to soil classification or by incorporating it within the soil classification.

3. Accumulation at the series level of all differentiating characteristics of higher categories.
   The committee concentrated on the influence of family criteria on the classification of series; The proposed textural limits cut across existing textural classes so that adoption of these limits would make the textural triangle obsolete; Because of uncertainties about the advantages and disadvantages of the textural and other limits, the committee does not favor adoption of these family criteria without further study. It seems clear that the family criteria will produce many and profound changes in the series classification.

In addition to its charge, this committee has considered the following items:

4. North Central region communication on substratum as a series or phase criterion; There is some reluctance in the North Central region to abandon substrata below the solum or control section as series criteria. A communication from the North Central soil survey work group to the western work group was referred to this committee. This communication presents a case for use, at the series level of profile characteristics to a depth of 60 inches rather than use of solum or control section characteristics. A majority of the committee prefers the uee of solum or control section characteristics.

5. Rocky phases. This committee agrees with the 1963 national committee that some rocky soil areas should be regarded as associations of soil and Rock Outcrop. The classes of rockiness defined in the Soil Survey Manual are appropriate for areas in which rock outcrops are present in a fine pattern, within the limits of the pedon; They do not apply where soil bodies consisting of more than one pedon are associated with rock outcrops. This committee recommends to the correlation staff that map units with significant components of soil and Rock Outcrop or Rockland

6.

7.

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Discussion:

Item 2c. Several parsons suggested that root growth may take place below 42°F. Differences among plant species were suggested;

Item 3; Dr. Kellogg said that in his mind the family category will be useful primarily for interpretations.

Item 4; Bill Johnson suggested that the characteristics of the "genetic profile," including developed horizons below the solum, are appropriate as series criteria, He pointed out that the Western Conference had voted in previous years in favor of restricting series criteria to characteristics of the "genetic profile;" The conference voted to affirm this position. Thus, unconforming substratum below the developed horizons would not be appropriate at the series level;

Item 6; Dr. Kellogg pointed out the difficulty of making volume estimations. Several persons commented on the importance of stoniness on a volume basis. Gene Steinbrenner said he had data relating volume content of stones to various forestry interpretations that is to be published in the proceedings of the 2nd N.A. forest soils conference;

Report of Ccmmittee No. 2
Soil Survey Maps and Publications, Including Benchmark
Soil Reports and Technical Soil Monographs

Western Regional Technical Work Planning
Conference of the Cooperative Soil Survey
Seattle, Washington
January 28-31, 1964

Introduction:

The committee discussed the report of the 1962 Regional Committee, the report of the 1963 National Technical Soil Survey Work Planning Conference, and other documents pertinent to the subject.

Objectives?

1. Review the new Guide for Writers of Soils Handbooks and Soil Survey Reports, and make recommendations for its improvement, further distribution, and use.

2. Review some of the problems related to scheduling and ccmpletion of soil surveys and publication of soil survey reports and maps to reduce the time between ccmpletion of the field correlation and having the report available for use,

3. Consider possibilities of assigning qualified individuals to complete benchmark soil reports.

4. Develop plans and set realistic goals for early completion of benchmark soil reports.

5. Consider necessary administrative action needed to assign responsibilities for early ccmpletion of technical soil monographs in selected areas of the Western States,

Recommendations:

1. Each State soil scientist send constructive criticism and suggestions for revision and/or improvement of the Guide for Writers of Soils Handbooks and Soil Survey Reports to Dr. Steele on or before July 1, 1964. The State soil scientist will obtain suggestions from all cooperating agenoies and from field soil scientists actually using the Guide, He will assemble these ideas into one document for the use of the Washington office in revising the Guide,

   Concern was expressed by the committee that sufficient copies of this Guide were not received for use by all soil scientists. It was explained that this was a trial run and if proven worthwhile, copies would be made available, Soils selected for benchmark distinction should receive early attention in new survey areas. Descriptions, mapping units, and problems in correlation are often major obstacles when compiling a report. For example, the Palouse series was originally considered to have the highest priority in Washington, yet its publication will be delayed many years if all the information on correlation and distribution is to be furnished,

2. Necessary corrections, revisions or additions be completed in 1964. On or before November 1 1965

3.

4.

5.

SUMMARY OF PROPOSED SOLUTIONS FOR THE BENCHMARK AND MONOGRAPH PROGRAMS UNDERWAY IN WASHINGTON

Briefly stated, the principal difficulty is to find persons with time, ability, and the inclination to do the writing or editing for these publications, The following approaches have been tried in Washington,

1. The Benchmark Committee for Washington in 1960 assigned certain soils to soil scientists from cooperating agencies. Each soil scientist was to be responsible for writing the report on one soil. This seemed to be a reasonable approach, but it has since proved to be otherwise, and for several reasons. First, the benchmark program was not a high priority part of anyones job, hence it received attention after other duties. Secondly most of soil scientists found that they needed more field and laboratory work to complete their assignments, and of course neither the field time nor laboratory facilities were readily available,

2. The second proposal was to use experienced personnel who are close to retirement and could be used in a special assignment to the project. However, a realistic appraisal of this proposal is not very promising. Very few persons are in this categorry, and further, the competition for their experience and writing ability is very keen, For example, many would rather accept, and are often encouraged to accept, a foreign assignment,

3. The third proposal was to start a graduate program using a benchmark soil as a thesis to fulfill graduate requirements for a masters degree in soils. This is acceptable to the Experiment Station and to the Graduate Faculty in Soils at Washington State University.

4. The fourth proposal was to place a man from the Soil Conservation Service on special assignment at the Experiment Station where he could use the laboratory facilities and as an added inducement perhaps attend graduate school. Other U.S.D.A. services have used this plan to train personnel and to do certain kinds of research,

5. The fifth proposal. was to make benchmark soils publications an Experiment Station sub-project in the National Cooperative Soil Survey Program. This is being tried at present.

Other problems relating to the publication of the Benchmark or Monograph programs are as follows:

These programs clearly need a higher priority and some "status" in the National Cooperative Soil Survey. This will undoubtedly require rewriting job descriptions and policies before personnel and facilities will be available to service the program.

Rogcrt of Committee No. 3
Soil Structure Committee

WESTERN REGIONAL TECHNICAL WORK FUNNING CONFERENCE FOR SOIL SURVEY

Seattle, Washington
January 27-31, 1964

This committee has attempted to respond to the recommendations set forth at the last meeting of the group in Las Cruces, New Mexico, and to the charges from the national committee on soil morphology meeting in Chicago, Illinois, March 25-29, 1963. The Committee has also prepared a reccmmendation for future work and, as such, this report consists of 3 distinct sections.

A. Items Included in the Regional Report

Three recommendations were made by the regional soil structure committee in 1962 and carried by vote of the conference at that time. In brief, these recommendations were as follows:

1. Continuation of a soil structure committee to deal with concepts of soil fabric.

2. Preparation of an annotated bibliography of papers and books presenting moder concepts of soil fabric, soil structure, cutans, etc.

3. The reccmmendation was that statements of moisture status be made in descriptions of soil structure.

In response to the first recommendation, S. W. Buol was named soil structure committee chairman at Las Cruces. By memorandum June 29, 1962, Ruben Nelson, R. C. McConnell and W. G. Harper (or replacement) were named to the committee. By memorandum December 18, 1963, the membership of the committee was changed, dropping Ruben Nelson and W. G. Harper and naming Maynard Fosberg, R. F. Tarrent and E. C. Steinbrenner. R. F. Tarrent and E. C. Steinbreoner withdrew from the committee prior to the meeting at Seattle, January 27, 1964.

In response to the reccmmendation to prepare an annotated bibliography of papers and books dealing with modern concepts of soil structure, the committee, by correspondence and deliberation at this meeting, reviewed and annotated 16 publications, This annotated bibliography is enclosed as appendix 1 of this report.

The recommendation to include a moisture statement in descriptions of soil structure was taken up by the national meeting and no further action on that item was pursued by the present regional soil structure committee.

B. Report of the National Committee on Soil Morphology

The national committee on soil morphology, March 28, 1963, proposed a scheme for the field description of clay films in soils and charged the regional structural committee to examine the scheme and report at their 1964 regional meetings. The scheme included 4 frequency classes, 5 thickness classes and suggested conventions for describing frequency, thickness and location of the clay films. This committee by transporting samples, thin sections, photomicrographs and hand lenses, tested the proposed scheme at this meeting. Briefly the five classes of thickness proposed by the national committee were as follows:

Very thin	0.005 mm	Not visible on cross section with 10x hand lens
Thin	0.005-0.05 mm	Visible with 10x but not unaided eye
Mod. Thick	0.050.5 mm	Visible with unaided eye
Thick	0.5-1 mm	Smooth the surface
Very thick	1 mm	

Using two 10x lenses, one 14x lens and one 20x lens, it was found from the examination of a stage micrometer that resolution of lines spaced at 10 microns was not possible by any committee members. All members, however, were able to resolve the 10 micron spacing with the 20x lens. It is pointed out that these are black lines on a transparent glass slide thus offering ideal contrast. Examination was also made of thin sections from a doil layer where the field party did not reoogniee clay films, but where later microscopic examination did reveal oriented clay films. Using 10x lenses, the members of the committee had difficulty seeing the films even in the thin section. Measurement of the clay film in photomicrographs revealed the film8 to be about 20 microns thick. From these observations, it was concluded that the very thin and thin classes be combined thus creating a class $\leq$ 50 microns thick,

Examination of thicker clay films, visible with the naked eye, revealed that they were usually quite variable in thickness. These films were in the range of 50 microns to 1 mm thick. It was the opinion of the committee that for field notation 50 microns to 1 mm be included as one class. A third class consisting of films over 1 mm thick was considered desirable.

The frequency1 classes described by the national committee were considered adequate and reasonable.

It was the considered opinion of the committee members that no classification of location or distribution pattern was necessary but that these items should be described in narrative as suggested in the conventions suggested by the national committee.

Discussion:

Kellogg: Why the emphasis on the term field terminology?

Buol: Present definitions included statements of clay orientation not determinable in fhe'field.

Johnson: Suggested that the committee work on nomenclature to help unify the field descriptions by party chiefs, etc.

Eickleberry: Express satisfaction with reducing the thickness classes from 5 to 3.

Johnsont Asked about Brewer's work on the classification of cutan and matrix boundary distinction,

Buolr Such fine distinctions were only applicable under microscopic examination end not in the field.

Committee No. 3

APPENDIX 1

ANNOTATED BIBLIOGRAPHY

Blumel, F., Janik, V., and Schiller, H. (1959) Die Mikromorphologie und der Kolloidzustand Underschiedlicher Bodentypen. Landwirtschaftlich-Chemische Bundesversuchsanstalt Linz/D, Fistschrift IX/4. (Osterreich)

Thin sections from several soils were studied and a procedure for determining and expressing a "collidmobility" factor was developed. This procedure involved several washings using first distilled water then 0.2 percent lithium carbonate solutions. They studied several soils using these washing techniques and were able to show differences usually related to organic matter and/or clay type. The method is empirical; however, it may be of some value in understanding illuvial cutan formation in soils.

Brewer, R. (1955) Mineralogical Examination of a Yellow Podzolic Soil Formed on Granodiorite, C.S.I.R.O. Soil Pub. No. 5.

No oriented clay was found in thin sections prepared from the B horizon of a Yellow Podzolic soil formed on Granodiorite. An interesting discussion of the profile and its microstructure is contained in the paper.

Brewer, R. (1956a) A Petrographic Study of Two Soils in Relation to their Origin and Classification. Soil Sci. 7:268.

Thin sections from two soils, a well-drained soil and an imperfectly drained soil, were studied. X-ray examination of the clay fractions was also done and it was concluded that clay type did not influence whether or not illuviation could take place in the profiles studied. It was further concluded that the strongly oriented clay deposits were

Brewer, R. and Sleeman, J. R. (1960) Soil Structure and Fabric, Their Definition and Description. Jour. of Soil Sci., Vol. II, No. 1, PP 172-185.

The various structural features commonly found in soils are examined by description and illustration. Terminology, similar to that used in geology, is proposed for each of the structural features.

Buol, S. W. and Hole, F. D. (1959) Some Characteristics of Clay Skins (Tonhautchen) on Peds in the B Horizon of a Gray-Brown Podzolic Soil. SSSAP Vol. 23:239-241.

Clay skins were separated from hostpeds in the B3 horizon of a Gray-Brown Podzolic profile and analyzed for C, N, free iron, total iron and clay content. X-ray diffraction patterns were also obtained. Several thin sections were studied and the morphology and distribution of ths clay skins are discussed.

Buol, S. W., and Hole, F. D. (1961) Clay skin Genesis in Wisconsin Soils, SSSAP, Vol. 25:377-379.

Thin sections were prepared fran each horizon of an Ockley-like Gray-Brown Podzolic profile. The distribution and amount of clay skin in each horizon was determined. The term clay skin is defined. Analysis of clay skin material separated from the B3 horizon revealed that it contained more P and Mn than the surrounding matrix. "Artificial" clay skins were produced in the laboratory by leaching virgin loess with dilute clay suspensions.

Cady, J. G. (1950) Rock Weathering and Soil Formation in the North Carolina Piedmont Region. Soil Sci. Soc. Amer. Proo. 15:337-342.

Several thin sections were studied from the Iredell and Davidson soil in the Piedmont region of the United States. Oriented clay made up 10% of the thin section area in the 10-foot depth and 20-25% of the area in the 5-foot depth in the Davidson soil. X-ray data from the coatings revealed finely divided kaolinite a8 the predominate mineral.

Carrol, D., Hathaway, J. E., and Stensland, C. H. (1963) Mineralogy of Selected Soils from Guam. Geological Survey Professional Paper 403-F.

This is a detailed mineralogical study on lateritic soils including many microphotographs.

Frei, E. and Cline, M. G. (1949) Micromorphological Studies of the Gray-Brown Podzolic--Brown Podzolic Sequence, Soil Sci. 68:333-344.

Strong concentrations of clays with a high degree of optical continuity were found in the B horizon of Gray-Brown Podzolic Soils,

Kubiena, W. L. (1938) Micropedology Collegiate Press, Ames, Iowa

Kubiena's book covers fabric analysis dealing with the microscopic investigation of natural fabric formation of soils. Descriptions, definitions, and discussion of formation are given for types of elementary fabrics, fabrics of aggregates and cleavage blocks, and fabric type in coherent soils. Techniques used in micropedology are given, McCaleb, S. B. (1959) The Genesis of the Red-Yellow Podzolic Soils. SSSAP 23:164-168.

From observations of clay-skins, he concluded that the B horizon development progress upward in Red-Yellow Podzolios.

Minashina, N. G. (1958) optically Oriented Clays in Soils, Soviet Soil Science No. 4. Translated. Dec. 1959.

The presence of optically oriented clays is shown to exist in several groups of soils in Russia.

Norgren, J. A. (1962) Thin-Section Micromorphology of Eight Oregon Soils. M. S. Thesis, Oregon State University.

This contains many microphotos of soil structure over the state of Oregon. Emphasis is on petrographic methods and there is an attempt to extend traditional soil profile descriptions to a microscopic level of detail.,

WESTERN REGIONAL WORK PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY
Seattle, Washington
January 27-31, 1964

REPORT OF COMMITTEE NO. 4 - SOIL SURVEYS ON RANGE AND FOREST LANDS

I. Committee Objectives

The overall objectives of this committee are to develop, record, and recommend principles which will assist in the design, conduct, and interpretations of soil surveys of range and forest lands.

II. Work Activities

During the past two years this committee has concentrated its efforts on developing guidelines for soil surveys on range and forest lands.

III. Findings

A. Survey Guides

Since soil surveys on range and forest lands are relatively young compared to those developed on cultivated lands, guides are needed to assist those engaged in this important phase of soil survey.

The Washington State Interagency Work Planning Conference has come up with a nice concise guide on Mapping Techniques and Criteria for Soil Surveys on Forest and Rangeland. Copies of this guide were circulated to the members of Committee No. 4 with request for comments about presenting this guide to the conference. All committee members were agreeable to this proposal with the idea in mind that the guide is a good preliminary step toward development of a more detailed guide in booklet form. The committee therefore recommends:

1. That copies of the Mapping Techniques and Criteria for Soil Surveys on Forest and Rangeland be distributed to the members of the Western Regional Technical Work Planning Conference.

It is recognized that the guide is a regional one that will need modification to meet needs In other parts of the Western United States. Even so, the guide contains a great deal of essential and useful information. The

B. 'Slope Phases

The very nature of mountainous and range terrain often demands use of miscellaneous units as mapping units. Moreover, the miscellaneous units can have slope phases that must be meaningful for the land manager. The slope phases can best be designated by slope ranges in percent. For example, stony land - Thunderbird **soil materials**, 30-60 percent slopes, or stony land, Thunderbird soil material, 60-80 percent slopes. The reader can think of a number of similar phases. All too often the slope percent range designations are lost through the process of field inspection, review, and correlation. Replacement of the slope designation usually is by adjectives such as steep or very steep. The use of adjective slope ratings cause many of our mapping units to lose their utility. What is steep or very steep to one person may not be the same to another.

Properly designated slope phases even of miscellaneous units have great use in hydrological interpretations, engineering applications, forestry, range use and management and in recreation interpretations. Thus, the committee recommends that:

1. Percent slope designations for slope phases of miscellaneous units and the like be used and retained throughout the process of identification and correlation.

C. Series Descriptions

Many new soil series are being described and proposed for use as surveys on forest and rangelands progress. These kinds of surveys are made on lands in which use functions will be those concerning native vegetation. Statements on vegetation within official descriptions of soil surveys normally associated with forest and rangelands generally need to be improved. The committee recommends that:

1. The National Technical Work Planning Conference for Soil Surveys consider development of a standardized procedure to better describe the kind and range of vegetation associated with the soil series associated with forest and rangeland. For example, a series may contain a statement under vegetation, to witness trees, shrubs, and grass. How much better it would be as - an open stand of ponderosa pine with an- understory of snowberry, spirea, Idaho fescue, and pine grass.

These descriptions need not be lengthy but should give a'general idea of the commonly associated vegetation., Assistance on this can be gained from foresters, range conservationists, and woodland specialists of 'the various agencies.

D. Landforms

Forest and range soil surveys are concerned with many and varied landshapes, or landforms, or landscapes, or pieces and parts of geomorphic surfaces or whatever you want to call them. The committee recognizes that in the western region, in the past, landforms have been used as terminology to express landscapes either within miscellaneous land types, or as topographic or slope phases of taxonanic soil units. There has not been common understanding or usage between soil scientists and geologists of the term landforms. Therefore the committee recommends that during 1964-1965, the committee will seek assistance from geologists and geomorphologists on the landform problem.

1. Get a clarification of scope, circumstance, and images created by use of the term landform,

2. That, within the region, a list of all those landscape conditions that have been called landforms by soil scientists be compiled. This list will be reviewed with geologists and geomorphologists to determine if they are landforms or merely adjective nomenclature for soil landscapes.

3. The list of names and definitions will be reviewed to see which ones properly fit as expansion of landforms in the miscellaneous lard types of the soil survey manual and which ones are more properly phase expressions of taxonomic soil units.

4. Upon completion of this review, whatever recommendations deemed necessary will be made to the correlation staff to accommodate additional topographic or slope phases or miscellaneous land type phases needed to accommodate proper expression of geologic and topographic landscapes in forest and range areas.

E. Special Endeavor

The committee wishes to direct the attention of the conference to the following idea.

> There is a prevalent impression among many people that surveys of forested lands or rangelands are synonomous with low intensity or reconnaissance work. This is far from the case. The committee therefore urges the conference to help us in improving and correcting the image of surveys on forest and rangelands.

The report was accepted as read. The conference voted to keep Committee No. 4 active.

IV. Future Committee Work

Continuation of development of guides and the work on landform definitions and usages (outlined in paragraph D above).

Committee Members:

J. R. Fisher
Milo James
R. C. Kronenberger
Vernon Chenowith
Stanley Gessel
P. O. Singleton
E. Wm. Anderson
Douglas Lacate
Wallace Hoffman
C. T. Youngberg
Warren Starr
Arthur Sherrill
E. C. Steinbrenner
J. A. Williams, Chairman

Report of
Committee on Climate No. 5
of the
Western Regional Technical Work Planning Conference
Seattle, Washington
January 28-31, 1964

The objective of this Committee is to continue the effort to develop a system for determining certain climatic factors which can be applied to soil and land classification and interpretation.

Activities of the committee during 1962 and 1.963 were as follows,

1. All states were requested to submit a report of progress which was in turn reported by R.J. Arkley to the National Technical Work Planning Conference at Chicago in 1963,

2. The following papers were published:

   a. The use of calculated actual and potential evapotranspiration for estimating potential plant growth, Hilgardia 32(10):443-461, May 1962, by R. J. Arkley and Rudy Ulrich.

   b. Relationship between plant growth and transpiration. Hilgardia 34(13):559-584, September 1963, by R.J. Arkley.

   c. Temperature and the water balance for Oregon Weather Stations. Oregon State University, Agr. Exp. Sta. Special Report 150:127 pp., May 1963, by C.A. Johnsgard.

   d. Calculation of carbonate and water movement in soil from climatic data. Soil Science 96(4):239-248, October 1963, by R.J. Arkley.

3. Activities reported by the states were as follows:

   Arizona: A report of computation is in preparation by Dr. Buol.

   California: Computations are complete and published in Hilgardia, including isoline maps,

   Colorado: Soil moisture effioienoy indices for the semi-arid Great Plains

New Mexico: Aztec Ruins, Gallup, Hachita, Lordsburg, Luna and Zuni were canputed in 1962.

Oregon: Precipitation, potential evapotranspiration surplus and deficits have been published for 214 stations; actual evapotranspiration has been computed for 100 stations.

Utah: All stations with data have been canputed but the information has not yet been published.

Washington: All stations with data were computed by the Weather Bureau, and isoline maps prepared and distributed.

Wyoming: All stations with data were computed by the Weather Bureau and will be published either by the University or by the Soil Conservation Service.

4. The climatic pattern was analyzed in relation to the distribution of Desert and grassland soils in Oregon, Washington, Montana and New Mexico. It was found that in New Mexico and Montana the calculation of Ea had to be modified to eliminate a portion of the summer rainfall after the grass had dried up, in order to obtain values which appeared consistent with those of Oregon and Washington, The modification excludes precipitation in the months following complete exhaustion of soil moisture until the first month in which ETp does not exceed twice the precipitation, This period is usually July and August in the Brown and Chestnut regions and July, August and September in areas of Desert soils,

The results were as follows:

4Ea

	Desert	Brown Red Br	Chestnut Red Chestnut	Chern ozem	Prairie
Washington	< 8	8-10	10 - 12.5	11.2-13.1	10.9-13.8
Oregon	< 8	8-10	10 - 13	13-16	16-22
Montana	--	g-9.5	9.5 - 13	15 (1 only)	--
New Mexico	< 4	4-10	8 - 11	--	--

Li (Cummulative Moisture surpluses)

	Desert	Brown Red Br	Chestnut Red Chestnut	Chern ozem	Prairie
Washington	< 3.5	3.5-4.5	4.5 - 10	4.5-10	> 10
Oregon	< 3.5	3.0-4.5	4 - 7	4 - 12	24-33
Montana	--	2.8-3.5	2.0 - 3.4	3.3 (1 only)	--
New Mexico	< 2.2	2-5	2.5 - 3.3	--	--

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5. At the National Soil Survey Work Planning Conference, March 1963, the committee on Climate stated, quote "The Committee recognized that no single climatic indices studied and tested to date would be applicable for all areas. The need for more reliable climatic indices for soil interpretation and classification still exists. Committee recommendations are: a. That the Western States continue their computations and testing of the water-balance method... ." Unquote.

6. Therefore, in accordance with this charge from the National Conference the committee makes the following recommendation:

   a. That all states complete the computations of potential and actual evapotranspiration for all stations for which normals of temperature and precipitation are available as recommended in 1962.

   b. That the seasonal and annual values be plotted on maps and isolines drawn as illustrated by the "California Land Capability Classification Guide."

   c. That these climatic values and maps be used to study the relationship between climatic values and the land use and soil patterns within each state,

   The committee recommends its continuance to give attention to problems such as those mentioned above and the chairman moves the adoption of this report.

   The report was accepted by the Conference,

   Committee members:

   R.J. Arkley*, Chairman
   L.E. Dunn*
   Marvin Magnuson*
   Dale Romine*
   Freeman Stephens
   Rudolph Ulrich

* Members attending the 1964 meeting at Seattle.

Discussion of report of Committee on Climate

Mr. Chapin urged that an effort be made to have more weather stations established to fill in gaps in various areas.

Mr. Hill suggested that it might be possible to obtain year round climatic data and soil temperature from the Oregon Snow Course.

Mr. Arkley urged that especially careful attention be given to the water balance and the calculation of actual evapotrenspiration in those areas where there is considerable precipitation during summer pericda when the grass is brown and in areas where summer fallow practices modify the water balance in relation to crop productions.

Report of
Organic Soils Committee
of the
Western Regional Technical Work Planning Conference
Seattle, Washington
January 28-31, 1964

At the Las Cruces Conference in 1962, proposals were made to determine a sound basis for classification of Histosols in the Seventh Approximation. In March 1963 the Organic Soils Committee of the National Technical Work Planning Conference of the Cooperative Soil Survey, under the guidance from Drs. Smith, Farnham and Dawson prepared tentative standards and criteria for classification of Histosols. These standards and criteria were tested, at the request of the National Committee, in Contra Costa County, California, Stevens County, Washington, and in the Puget Sound Area of Washington.

Objectives of the Organic Soils Committee of this conference are:

1. Review results of field tests from the three areas and prepare a record of suggestions for improvement.

2. Recommend investigations needed to improve field classification and mapping of Histosols.

FIELD TESTING OF STANDARDS AND CRITERIA:

1. Organic soil profile descriptions were prepared in each area making tests, using criteria outlined by the National Committee. The three groups making the tests agreed the criteria were presented in a logical and usable manner.

2. All those making tests agreed thickness of the control section; 40 inches drained and 60 inches undrained, is satisfactory.

3. Mineral soils underlying organic soils at depths of less than 40 inches is common to all the areas. Classification of Orders is based on the layer immediately underlying the surface 12 inches, Where drained this underlying layer must be 12 inches thick and where undrained it must be 18 inches thick. Suborders are based on the presence of a mineral horizon underlying organic materials. (i.e. Aquentj

   Families are based on texture of the underlying mineral soil, The mineral material is broadly classified as sands, loams, or clays. These criteria are logical and workable in the field.

4. The diagnostic horizons - Sapric and Fibric were readily identified in the field. The Lenic horizon is intermediate in decomposition and disintegration between Sapric and Fibric. A Lenic Horizon was difficult to consistently identify and separate from a Sapric horizon.

   The sodium pyrophosphate test to separate peat and muck was found to be inconclusive. A Fibric Horizon has a pyrophosphate test with color values higher and chromas lower than 7/3. A Sapric horizon has pyrophosphate test color values lower and chromas higher than 7/3. Several of the tests were on the border - 10YR 7/3. This was borderline between muck and peat. Hence, based upon the test the horizon is considered Lenic.

5. Laboratory characterization of modal soils is recommended to determine fiber length and develop standards for uniform field identification and mapping.

   a. The N-factor, *squeeze or ooze' test correlates well with peat and muck. Standardized calibration is desirable using subsamples of modal soils that have been characterized in the laboratory.

   b. Reaction determinations were difficult in all areas, Dark colors of mucks masked the colors of dyes. Dyes were apparently satisfactory for reaction determinations of Fibric horizons. This committee recommends the use of a portable pH meter,

   c. Difficulty was encountered in differentiating between muck and mineral soil in areas where organic matter approached the minimum for muck soils. This Committee recanmends laboratory characterization of modal soils in this category and distribute reference subsamples.

6. Modal cat-clay soils need characterization studies as a guide for field identification and mapping. Soils that'possibly have cat-clay properties have been observed on tide flats of California and Washington coasts.

It is reccmmended to this conference that the Organic Soils Committee continue to function until the classification of Histosols is established and criteria and standards are tested in the field, Ccmmittee members will exchange observations and data,

Ccmmittee	Participating
L.R. Wohletz	R.W. Chapin
O.D. Mueller	R. J. Arkley
F.E. Schlots, Chairman	

Discussion of Ccmmittee Report No. 6 (Attachment No.1)

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Report of
Made or Shaped Soils Committee No. 7
of the
Western Regional Technical Work Planning Conference
Seattle, Washington
January 28-31, 1964

I. Objectives

A. Review and recommend as needed revisions or new definitions for Made Land, Made Soils, and Shaped Soils.

B. Review and recommend criteria and nanenclature for the classification of Made Soils and Shaped Soils.

II. Proposals and Recommendations

A. The committee reviewed the definition of Made Land and are of the opinion that this miscellaneous land type should be restricted as follows:

Areas artificially filled with trash and other materials not suitable for the economic production of crops, trees, range forage, ornamental shrubs, flowers, lams, etc.

B. In addition to Made Land, the committee recommends that the following two categories be recognized:

1. Made Soils

2. Shaped Soils

C. Nade Soils

1. Made Soils will comprise those soils that are mechanical mixtures of sola and parent materials from one or more other soils, or artificial fills of earthy materials, suitable for the economic production of crops, trees, range forage, ornamental shrubs, flowers, lawns, etc. Three kinds of Made Soils have been recognized as follows:

a. Made soils in which the control section or diagnostic horizons have been mixed, changed or altered so that they are no longer discernible.

(1) It is recommended that criteria for classification and nomenclature be the same as that now used for Alluvial Soils and Regosols. This, therefore, may involve the change of the original soil to a new soil series or another soil series already recognized and established.

b. Made soils in which the original diagnostic horizons have been mixed sufficiently to destroy the normal sequence, but not to the extent that the fragments or parts of the horizons can no longer be identified.

(1) It is recommended that criteria for classification and nanenclature be the same as that now used for Alluvial Soils and Regosols. In addition the presence of fragments of the original diagnostic horizons should be considered as series criteria.

c. Made soils that consist of artificial fill of earthy materials,

(1) It is recommended that criteria for classification and nomenclature be the same as that now used for Alluvial Soils and Regosols. It should be recognized that many filled areas may consist of complexes of several made soils. In these instances the constituent soils should be identified. Should the fill material be of such a heterogeneous nature that it is not possible nor practical to identify constituent soils, it is recommended that such made soils be identified and mapped as "Wade Soil Complexes".

D. Shaped Soils

1. Shaped soils are those soils which have been smoothed or graded without extensive mixing or filling of earth materials. Although the diagnostic horizons of the original soil may be interrupted and not continuous throughout the landscape, they are still present and discernible in a major portion of the soil under consideration.

a. It is recommended that these kinds of soils be identified as "shaped" phases of the original soil,

b. In the event that the range in horizon variability is not included in the pedon for the soil under consideration, it may be necessary to recognize a complex of a Made Soil and Shaped Soil phase.

III. Future Activities of the Committee

A. The ccmmittee recognizes that additional work remains, particularly in regard to the development of criteria for classification and nomenclature for shaped soils. It is recommended that future activities of this committee and other Regional and the National Committee give this matter high priority.

B. The ccmmittee also recognizes that rather serious problems exist in 'regard to the degree and nature of alteration that it is necessary to consider for series criteria. It is recommended that Regional and National Committees on "Criteria for Soils Series, Types and Phases" give this problem attention in future work,

IV. Recommendation For Continuing the Committee

It is reccommended that the committee be continued, and that the Steering Committee restate the charge and scope in order to particularly avoid overlap with the committee on "Criteria for Soil Series, Types and Phases".

Committee Members

*E. A. Naphan, Chairman
W. Scott Wood
John Douglas
J .M. Williams
*H.J. Maker
E.N. Poulsen
*Joe Kingsbury

*Present at conference

Visitors

Dr. C.E. Kellogg
W.M. Johnson
A, Nelson

Committee Report No. 8

Committee on Soil Surveys on Urban and Fringe Areas,
Design and Interpretation

Introduction:

Soil surveys are useful for the development of urban and fringe areas because they provide information about both the nature and the distribution of soils. This information includes both field observations and laboratory measurements, and ranges from apparently simple to complex,

The major potential of soil survey information in this respect is for the prediction of hazards. Thus, soil surveys do not take the place of on-site engineering testing any more than they take the place of fertility testing. They do, however, point out potential hazards which must be considered in planning. These hazards or limitations may apply to the design of structures or sewage disposal

5; We suggest using soil pH rather than acidity in discussing factors affecting the life of concrete tile. This is based on the fact that strongly alkaline conditions can cause deterioration of concrete.

Draft on Septic Tank Filter Fields

We suggest improving the definition of septic tank filter fields and offer the following for consideration: "The septic tank filter field is a subsurface tile system laid to permit distribution of the effluent from the septic tank into the soil."

Draft on sewage lagoon requirements and the criteria. used in evaluating the degree of limitation6 of soils for developing lagoons;

1. We suggest that sewage lagoon8 be defined, and offer the following for consideration: "A sewage lagoon is a shallow lake used fo hold sewage for the time required for bacterial decomposition."

2. Because synthetic detergents are known to have important effect6 on soil permeability, we suggest consideration of such effect6 in the discussion.

Draft of Shrink-swell behavior classes

We have no criticism of either this report or the report on vertical soil movement by Dr; Grossman. We do believe a comparison of results from Dr. Grossman8 method with results from the PVC meter described by FHA would be valuable.

Recommended courses of action:

1. We recommend that states with expanding urban areas make soil surveys of small areas where problems are forseen, then develop urban interpretations for these area8 a8 soon a8 possible. Theae small areas could be parts of existing soil survey publication areas. Alternatively, urban interpretation reports could be developed for recently published surveys in such areas.

2. Urban Interpretation sections or reports could be developed by either the SCS or the Agricultural Experiment Station in that state working cooperatively with various planning groups; The content of such materials should vary with the nature of anticipated problems.

3. To be useable by a wide variety of groups with interest6 ranging from planning to engineering design, urban interpretations should be written in simple, non-technical language. If specialized terminology must be used, it should be defined. Single factor maps appear particularly appropriate for presenting this information;

4. For engineering

5.

6. The need for experience in urban interpretation may seriously limit the effectiveness of such indeavors. We recommend arrangements to permit detailing SCS soil scientists to areas where soil surveys are being put to use for urban planning so that they may profit from the experience of others in these applications.

7s The committee recommends its continuation,

Bibliography:

Assemble single alphabetical list from the two attached lists and the two references which follow:

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Massachusets Dept. of Commerce; Soils Interpretation for Community Planning II. Effectuation of Soils Interpretation for Twon of Hanover.

Add at the end of this list, but separated from it the following: Sets of 35 mm transparencies illustrating the use of single factor maps for the presentation of interpretive material are available from the office of the direction of soil survey interpretations. Soil Conservation Service. Beltsville, Maryland.

Committee Members:
J. U. Anderson* Chairman
L. E. Dunn*
R. Ulrich
L. Wohletz*
*Resent at Conference

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Summary Remarks to Conference

by

Dr. C. E. Kellogg

This is my first meeting with this group; You know, all government employees have job descriptions. My job description is to comfort the disturbed, and to disturb the comfortable. It is always good to get out of the office and find something good developing in the soil survey program.

First I should like to comment that there are not enough publications in the journals from you people, and for the men you represent in the field. One does not need earth shaking evidence for a journal article; There is room for small bits of important information. Most communication is by writing - not by word of mouth; In the area of problem solving - for instance the urban land development problems - there is an equal opportunity to express nature of the problem and possible remedies, We have requests from fertilizer and canning companies, as to choice of locations for a plant. While present land use does not support the establishment, a fair appraisal of Land potential might support the establishment;

We must minimize as much as Possible the size of field parties for reviews, inspections and correlations. In some instances they became too large. This